Volume 1

EFFECT OF RADIATION ON HUMAN HEALTH

Health Effects of Ionizing Radiation

HEARINGS

BEFORE THE

SUBCOMMITTEE ON HEALTH AND THE ENVIRONMENT

OF THE

COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE

HOUSE OF REPRESENTATIVES

NINETY-FIFTH CONGRESS

SECOND SESSION

ON

OVERVIEW OF THE EXTENT TO WHICH THE GENERAL PUBLIC IS EXPOSED TO RADIATION, THE EFFECTS OF RADIATION ON HUMAN HEALTH, AND TO DETERMINE WHETHER EXISTING LAW IS ADEQUATE TO PROTECT THE PUBLIC

JANUARY 24, 25, 26, FEBRUARY 8, 9, 14, AND 28, 1978

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CONTENTS

Page

Hearings held on—
- January 24, 1978 1
- January 25, 1978 137
- January 26, 1978 331
- February 8, 1978 489
- February 9, 1978 739
- February 14, 1978 905
- February 28, 1978 1207

Statement of—
- Albers, W. R., M.D., Chief, Occupational Medicine Branch, Division of Environmental Safety, Department of Energy 1338
- Amick, Richard, Office of General Counsel, Nevada Operations Office, Department of Energy 331
- Belhumeur, Roland, Dover, N.H 1326
- Bond, Victor, M.D., Associate Director, Brookhaven National Laboratory, Department of Energy 331
- Brodsky, Allen, Sc. D 869
- Bross, Irwin D. J., Ph. D., director of biostatistics, Roswell Park Memorial Institute 905
- Broyhill, Hon. James T., a Representative in Congress from the State of North Carolina 139
- Burr, William, Jr., M.D., Deputy Director, Division of Biomedical and Environmental Research, Department of Energy 331
- Caldwell, Glyn, M.D., Lead Epidemiologist, Center for Disease Control, Public Health Service, Department of Health, Education, and Welfare .. 195
- Church, Bruce, Branch Chief for Radiation Safety, Nevada Operations Office, Department of Energy 331, 1135
- Craft, Bobby F., Director, Division of Surveillance, Hazards Evaluation and Field Studies, Center for Disease Control, Public Health Service, Department of Health, Education, and Welfare 1332
- D'Amours, Hon. Norman E., a Representative in Congress from the State of New Hampshire 1231
- Dann, Russell Jack, Alberta Lee, Minn 142
- Deline, Maj. Donald A. (Army), Department of Defense 135
- Durkin, Hon. John A., a Senator in Congress from the State of New Hampshire 1217
- Finkelstein, Milton M., Comdr. (Navy), Department of Defense 1095, 1100
- Foege, William H., M.D., Director, Center for Disease Control, Public Health Service, Department of Health, Education, and Welfare 195, 1332
- Gilbert, Ethel S., Ph. D., biostatistics, Pacific Northwest Laboratory . 634, 640, 739
- Haas, Peter H., Deputy Director, Science and Technology Defense Nuclear Agency, Department of Defense 218, 1095
- Haber, Paul A., M.D., Assistant Chief Medical Director for Professional Services, Department of Medicine and Surgery, Veterans' Administration 461, 1180
- Hathaway, Hon. William D., a U.S. Senator from the State of Maine 1233
- Hobson, Lawrence O., M.D., Deputy Assistant Chief Medical Director, Research and Development, Veterans' Administration 1180
- Hollister, Hal, Director, Division of Operational and Environmental Safety, Department of Energy 331, 1135
- Howard, Tounsel, Leeburn, Ky 491
- Hugo, Victor J. (Army), Department of Defense 1095, 1097
- Hutchison, George B., M.D., M. Ph., professor of epidemiology, Harvard School of Public Health 634, 656, 734
- Jablon, Seymour, Staff Director, Medical Followup Agency, National Research Council, National Academy of Sciences 634, 1076

Statement of—Continued Page

Jacks, Gordon, Los Alamos Scientific Laboratory, Nevada Test Site, Department of Energy 331, 1135
Joftes, David L., Ph. D., Chief, Review and Referral Branch, Division of Cancer Research, Resources and Centers, National Cancer Institute, National Institutes of Health, Public Health Service, Department of Health, Education, and Welfare 1019
Johnson, Charles, Assistant General Counsel, Veterans' Administration ... 1180
Jones, Dorothy B., member, steering committee, Another Mother for Peace. 183
Keating, Lt. Col. Frank W. (Ret.), Tacoma, Wash 142, 145
Kerr, Donald, Ph. D., Acting Assistant Secretary for Defense Programs, Department of Energy 331, 1117, 1135
Kneale, George 523
Kush, George S., Lt. Col. (Air Force), Department of Defense 1095, 1105
Land, Charles E., Ph. D., Statistician, Health Environmental Epidemiology Branch, Division of Cancer Cause and Prevention, National Cancer Institute, National Institutes of Health, Public Health Service, Department of Health, Education, and Welfare 1019
Liverman, James L., Ph. D., Acting Assistant Secretary for Environment, Department of Energy 634, 739, 1338
Lushbaugh, C. C., M.D., Ph. D., chief, medical health services, medical division, Oak Ridge Associated Universities 787
McDonough, Capt. William D., Portsmouth Naval Shipyard, Department of Defense 1267
McIndoe, Col. Darrell W., M.D., Director, Armed Forces Radiobiology Research Institute, National Naval Medical Center, Department of Defense 218, 219
McIntyre, Hon. Thomas J., a U.S. Senator from the State of New Hampshire 1209
Mancuso, Thomas F., M.D., research professor, department of industrial environmental health sciences, Graduate School of Public Health, University of Pittsburgh 523
Marks, Sidney, M.D., Ph. D., biostatistics, Battelle Corp 634, 739
Miles, Murray, Chief, Nuclear Technical Division, Department of Defense... 1267
Milham, Samuel, Jr., M.D., population studies unit, Washington State Department of Social and Health Services 495
Millar, J. Donald, M.D., Acting Director, National Institute for Occupational Safety and Health, Center for Disease Control, Public Health Service, Department of Health, Education, and Welfare 1332
Moloney, William C., M.D., director, hematology division, Peter Bent Brigham Hospital (Mass.), consultant to Veterans' Administration 461, 471
Monroe, Robert R., Vice Adm. (USN), Director, Defense Nuclear Agency, on behalf of Secretary, Department of Defense 1095
Morgan, Councilman, M.D., Executive Director, Assembly of Life Sciences, National Research Council, National Academy of Sciences 1076
Morgan, Karl Z., Ph. D., Neely professor, School of Nuclear Engineering, Georgia Institute of Technology 4
Najarian, Thomas, M.D., fellow in hematology, Veterans' Administration Hospital, Boston 1234
Negron, Rafael, Maj. (Marine Corps), Department of Defense 1095, 1108
Newman, Bob, Deputy Assistant Manager for Operations, Nevada Operations Office, Department of Energy 331
Peckarsky, J. C., Director, Compensation and Pension Service, Department of Veterans' Benefits, Veterans' Administration 461, 1180
Putnam, Frank W., Chairman, Assembly of Life Sciences, National Research Council, National Academy of Sciences 1076
Pyatt, Everett A., Principal Deputy Assistant Secretary of the Navy (Logistics), Department of Defense 1267
Radford, Edward P., M.D., Ph. M., professor of environmental epidemiology, Graduate School of Public Health, University of Pittsburgh 727
Rickover, Adm. H. G., Deputy Commander, Nuclear Power Naval Sea System Command, USN, Department of Defense 1267, 1270
Rivera, Capt. Julio D., M.D., Director, Division of Undersea Medicine, Bureau of Medicine and Surgery, Department of Defense 1267
Seltzer, Joseph, Acting Inspector General, Department of Energy 634, 739
Shuman, Sidney, Chairman, Board of Veterans' Appeals, Veterans' Administration 461, 1180

Statement of—Continued — Page

- Skerker, Maj. Alan L., member, Nuclear Division, Strategy, Plans, and Policy Directorate, Office of Deputy Chief of Staff for Operations and Plans, Department of the Army, Department of Defense 218, 231, 1095
- Smith, Hubert, Asheville, N.C 142, 159
- Smith, James J., M.D., Director of Nuclear Medicine Service, Department of Medicine and Surgery, Veterans' Administration 461, 462, 1180
- Sparks, Henry A., M.D., Rear Adm., Assistant Chief of Medical Support, Bureau of Medicine and Surgery (Navy), Department of Defense 1095
- Sperling, Martin, Ph. D., senior scientist, Science Applications, Inc 4, 50
- Stedman, Col. Thomas M. (Ret.), Savannah, Ga 142, 147
- Stewart, Alice, M.D., epidemiologist 523
- Taft, Robert, Assistant Manager for Plans, Engineering and Budget, Nevada Operations Office, Department of Energy 331
- Tamplin, Arthur, Ph. D., staff scientist, National Resources Defense Council 4, 21
- Tompkins, Edythalena, chief epidemiologist, medical division, Oak Ridge Associated Universities 787
- Tompkins, Paul, former executive director, Federal Radiation Council .. 787, 866
- Tyler, Paul, Capt., Medical Corps, U.S. Navy, Deputy Director of the Armed Forces Radiobiology Research Institute, Department of Defense 1095
- Upton, Arthur C., M.D., Director, National Cancer Institute, National Institutes of Health, Public Health Service, Department of Health, Education, and Welfare 1019
- Weiss, Daniel, M.D., Executive Secretary, Division of Medical Sciences, Assembly of Life Sciences, National Research Council, National Academy of Sciences 1076
- Weyzen, Walter, M.D., Ph. D., Division of Biological Environmental Research, Manager, Human Health Studies Program, Nevada Operations Office, Department of Energy 331, 634, 739, 1338

Additional materials submitted for the record—

- Another Mother for Peace, attachments to Mrs. Jones' prepared statement:
  - Letter, dated October 6, 1977 from Artie E. Duvall, Jr., to Mr. Cleland re his physical condition from being involved in nuclear tests, and reply letter 191, 192
  - Letter, dated January 20, 1978, from Ronald G. Bakal to Chairman Rogers, re representing the inhabitants of Utirik Atol in the Marshall Islands 193
- Brodsky, Allen, Sc. D., attachments to prepared statement:
  - References referred to in prepared statement 877
  - Reference 3—Letter, dated February 1, 1978 from Dr. Brodsky to Dr. Mancuso 878
  - Reference 4—Memorandum, Comments on published version of paper by Mancuso, Stuart, and Kneal, with introductory letter 881
- Bross, Irwin D. J., Ph. D., director of biostatistics, Roswell Park Memorial Institute, attachments to prepared statement:
  - Excerpt from Courier Express, column by Anderson on radiation rapped 999
  - Excerpt from Courier Express, "Radiation Hazards Suppressed," by Jack Anderson 998
  - Hazards to persons exposed to ionizing radiation (and their children) . 913
  - Letter dated December 1, 1977, from Dr. Bross to Dr. Taylor re denying the validity of the scientific research of Drs. Mancuso and Bross 1000
  - Letter dated December 16, 1977, from Dr. Taylor to Dr. Bross re answer to December 1, 1977, letter 1001
  - Letter dated January 18, 1978, from Dr. Bross to Michael Parsont re speaking at the Nuclear Regulatory Commission meeting 1002
  - Letter dated February 1, 1978, from Mr. Minogue to Dr. Bross re comment on some areas which may not have been touched in previous correspondence 1005
  - Letter dated February 6, 1978, from Mr. Kelley to Mr. Roisman re setting date for public meeting with Dr. Bross 1007
  - Listing of slides 979
  - Report on the action of two Federal agencies, ERDA and NCI, in terminating funding for two major studies of the health hazards produced by low levels of ionizing radiation 951
  - Suppression of scientific research in the United States: The mechanics 995

Additional materials submitted for the record—Continued

Page

- Broyhill, Hon. James T., a Representative in Congress from the State of North Carolina, attachment to his prepared statement, re letter from Roy D. Huffstetler claiming veterans' compensation benefits for service-connected disability ... 139
- Dann, Russell Jack, letter dated December 23, 1977, from Veterans' Administration to Mr. Dann, re denial of compensation ... 180
- Defense Department:
  - Action taken regarding Congressman Teague's letter of January 8, 1970 ... 1132
  - Additional Army staff in the Army Secretariat ... 1098
  - Additional funding for extensive study by DOD ... 1118
  - Agencies and persons contacted ... 307
  - Air Force atmospheric nuclear weapons testing team ... 1107
  - Atmospheric nuclear test review personnel roster ... 313
  - Attachments to Dr. McIndoe's prepared statement:
    - Executive summary, military participation in atmospheric nuclear tests ... 227
    - Summary report, December 1, meeting on possible long-term medical consequences of atmospheric nuclear testing ... 224
  - Desert Rock personnel exposure ... 279
  - Individuals exceeding 5 rem ... 304
  - Marine Corps Headquarters Committee ... 1110
  - Monthly film badge exposures (all services), Operation Crossroad (1946) ... 1107
  - Occupational radiation exposures received by personnel in the naval nuclear propulsion program ... 1278
  - Personnel participation in nuclear weapons testing ... 222
  - Pyatt, Everett A., attachments to prepared statement:
    - Letter, dated February 24, 1978, from W. Graham Claytor, Jr., to Secretary Califano, re study to be accomplished at Portsmouth Naval Shipyard ... 1269
    - Letter, dated February 24, 1978, from W. Graham Claytor, Jr., to Hon. Thomas J. McIntyre, re Navy cooperation in the efforts for study at Portsmouth Naval Shipyard ... 1270
  - Rate of all diseases and cancers among nuclear and diesel submariners ... 1130
  - Replies to questions given to Defense representatives ... 1119
  - Status of the first crew of USS *Nautilus* (SSN-571) ... 1129
  - U.S. Navy atmospheric nuclear testing program ... 1102
- Durkin, Hon. John A., a U.S. Senator from the State of New Hampshire, attachments to his prepared statement:
  - Article from Boston Globe: "The Danger of Radiation at the Portsmouth Shipyard" ... 1226
  - Letter, dated February 25, 1978, from Senator Durkin to President Carter, re encouraging a panel be established for the investigation of nuclear shipyards ... 1221
  - Letter, dated January 27, 1978, from Senator Durkin to Secretary Schlesinger, re investigation of DOE officials in regard to their attitude of research into health effects of low-level radiation at nuclear shipyards ... 1224
- Energy Department:
  - Attachments to Dr. Kerr's prepared statement:
    - Announced U.S. nuclear detonations ... 341
    - Baneberry summary report ... 368
    - Summary information on accidental releases of radioactivity to the atmosphere from underground nuclear detonations designed for containment ... 384
  - Copies of public expressions of concern regarding the safety of nuclear facilities ... 1358
  - Correlation of experience of employees with radiation exposure ... 678
  - Discussions and recommendations concerning a projected ORAU program of human studies and radiation medicine activities ... 698
  - DOE/NV personnel dosimetry records by location and year ... 407
  - DOE responses to questions from the Subcommittee on Health and the Environment:
    - Questions A-1 through A-10 ... 439
    - Questions B-1 through B-15 ... 1149

Additional materials submitted for the record—Continued

- Energy Department—Continued — Page
  - Fiscal year 1977 operation No. 14—September 16, 1977 724
  - Liverman, James L., Ph. D., Acting Assistant Secretary for Environment, statement of Victor P. Bond 660
  - Radiation exposures 758
  - Review of analysis of Hanford mortality 769
- Health and the Environment Subcommittee, Interstate and Foreign Commerce Committee:
  - Excerpts from "Silent Slaughter" 811
  - Letter, dated January 12, 1978, from Chairman Rogers to DOD Secretary Brown, re release of classified material on "Smoky" and "Plumbob Series" test programs and public health consequences 269
  - Letter, dated January 13, 1978 from Disabled American Veterans to Chairman Rogers re assistance to veterans and their dependents on disability or death benefits resulting from radiation exposure 141
  - Regulation—Permissible doses, levels, and concentrations 755
  - Standard observer grouping, rostering, and convoy procedures for Camp Desert Rock 1103
- Health, Education, and Welfare Department:
  - Low-level radiation contracts and interagency agreements 1056
  - Low-level radiation grants 1047
  - National Cancer Institute, program projects 1074
  - Resources for epidemiologic investigation of 3,153 men exposed to atomic nuclear radiation, August 31, 1957 202
  - Roster—Clinical Cancer Program Project Review Committee 1039
- McIntyre, Hon. Thomas J., a U.S. Senator from the State of New Hampshire, attachments to prepared statement:
  - Letter dated February 24, 1978, from Secretary Claytor to Senator McIntyre re offering Navy cooperation in the study of Portsmouth Naval Shipyard 1213
  - Letter dated February 24, 1978, from Secretary Claytor to Secretary Califano re cooperation of the Navy with CDC by providing to them the records necessary for the Portsmouth Naval Shipyard study 1214
- Mancuso, Thomas F., M.D., research professor, department of industrial environmental health sciences, Graduate School of Public Health, University of Pittsburgh:
  - Attachments to prepared statement:
    - AEC press release read over telephone to Thomas Mancuso 559
    - Estimated additional costs 1973-1975 (chart) 571
    - Letter dated January 16, 1976, from Sidney Marks to Dr. Mancuso re renewal of project 567
    - Letter dated August 12, 1976, from Dr. Mancuso to Fred Becher with attached letter to Dr. Sanders 568
    - Letter dated February 16, 1977, from Dr. Mancuso to Dr. Weyzen re reminder to ERDA of the provisions of the agreement with social security 560
    - Letter dated March 29, 1977, from Dr. Weyzen to Ms. Borchmann re article dated October 27, 1976 in Los Angeles Times for Weyzen's response 572
    - Memorandum meeting; January 8, 1976 563
  - Radiation exposures of Hanford workers dying from cancer and other causes—a review of written criticisms by A. M. Stewart and G. W. Kneal 574
  - Radiation exposures of Hanford workers dying from cancer and other causes, excerpt from Health Physics 1977 601
- Morgan, Karl Z.:
  - Attachments to prepared statement:
    - International Radiation Protection Association, proceedings 17
    - References for prepared statement 15
    - Table 1—Changes in levels of permissible exposure to ionizing radiation 13
    - Table 2—Cancer risk and known range of linearity 14
  - Censured or repressed scientific information with attachments 74
  - Letter, dated February 3, 1978, from Karl Morgan to Chairman Rogers re questions and answers 130

Additional materials submitted for the record—Continued — Page

Najarian, Thomas, M.D., fellow in hematology, Veterans' Administration Hospital, Boston, attachment to prepared statement, Navy responses to Boston Globe questions ... 1243

National Academy of Sciences:

Letter, dated March 21, 1978, from Philip Handler to Chairman Rogers ... 1092

Suggested draft language response ... 1094

National Resources Defense Council, attachments to Dr. Tamplin's prepared statement:

Biological effects of radiation; 10 times worse than estimated ... 24

British Journal of Radiology, the, Sir E. E. Pochin ... 40

Enclosure A—Risk factor for radiation-induced leukemia among entrants to Hiroshima, Dr. J. Rotblat ... 43

Saenger, Eugene L., M.D., professor of radiology, college of medicine, University of Cincinnati, letter and attachments dated May 9, 1978, to Chairman Rogers re references of Representatives Walgren and Carter on February 9, 1978, hearing ... 820

Science Applications, Inc., attachments to Dr. Sperling's prepared statement:

Nevada Test Organization press releases ... 58

Probable radiation exposure levels experienced by participants, figures 1, 2, 3 ... 55, 56, 57

Stedman, Col. Thomas M. (Ret.), attachments to prepared statement:

Annex A—Movement orders ... 152

Annex C—Administrative instructions ... 155

Brochure—Headquarters Exercise Desert Rock VII and VIII ... 171

Minimum clothing and equipment requirements ... 157

Pilot log book ... 149

Veterans' Administration:

Attachments to Dr. Haber's and Dr. James J. Smith's prepared statement:

Appendix I—Compilation of veterans who participated in atomic tests since 1946 ... 465

Appendix II—Data compiled by Board of Veterans' Appeals ... 468

Questions and responses to Privacy Act with forwarding letter from Charles M. Jackson ... 1186

Responses to questions concerning adjudication of claims ... 1205

Washington State Department of Social and Health Services, attachments to Dr. Milham's prepared statement:

Attachment 2—Unpublished manuscript ... 497

Attachment 3—Letter dated June 28, 1974, to Dr. John Beare ... 502

Attachment 4—NIOSH research reports I and III ... 503

Attachment 5—Proportional mortality analysis of Hanford deaths ... 514

ORGANIZATIONS REPRESENTED AT HEARINGS

Another Mother for Peace, Dorothy B. Jones, member, steering committee.

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Deline, Maj. Donald A. (Army).

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Rivera, Capt. Julio D., M.D., Director, Division of Undersea Medicine, Bureau of Medicine and Surgery.

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Defense Department—Continued
- Sparks, Henry A., M.D., Rear Adm., Assistant Chief of Medical Support, Bureau of Medicine and Surgery (Naval).
- Tyler, Paul, Capt., Medical Corps, U.S. Navy, Deputy Director of the Armed Forces Radiobiology Research Institute.

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- Burr, William, Jr., M.D., Deputy Director, Division of Biomedical Research.
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- Hollister, Hal, Director, Division of Operational and Environmental Safety.
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- Moloney, William, C., M.D., director, hematology division, Peter Bent Brigham Hospital (Mass.), consultant to the Veterans' Administration.
- Peckarsky, J. C., Director, Compensation and Pension Service, Department of Veterans' Benefits.
- Shuman, Sidney, Chairman, Board of Veterans' Appeals.
- Smith, James J., M.D., Director of Nuclear Medicine Service, Department of Medicine and Surgery.

Washington State Department of Social and Health Services, Samuel Milham, Jr., M.D., population studies unit.

EFFECT OF RADIATION ON HUMAN HEALTH

Health Effects of Ionizing Radiation

TUESDAY, JANUARY 24, 1978

House of Representatives,
Subcommittee on Health and the Environment,
Committee on Interstate and Foreign Commerce,
Washington, D.C.

The subcommittee met, pursuant to notice, at 1:30 p.m., in room 2322, Rayburn House Office Building, Hon. Paul G. Rogers, chairman, presiding.

Mr. Rogers. The Subcommittee on Health and the Environment will come to order, please.

Today's hearings are the first of several which are designed to give the committee an overview of the extent to which the general public is exposed to radiation, the effects of radiation on human health and to determine whether existing law is adequate to protect the public health.

This committee wrote the Radiation Health and Safety Act of 1968 when it became clear that existing law was lax. Since then there has been a proliferation of the use of devices utilizing radiation which makes this overview necessary.

The general assumption is that most people come into contact with radiation via medical and dental examination through X-ray procedures. Indeed, there is extensive use of medical and dental diagnostic machinery. In 1977, it is estimated that 160 million Americans received one or more X-ray examinations. In all, the Food and Drug Administration estimates that 270 million procedures were carried out during 1977.

But beyond this, the general public comes into contact with radiation in an ever-increasing variety of ways. Microwave ovens are now in millions of homes. Last year, more than 200 million passengers traveled by commercial airplane and most passed through security systems which involved X-rays. Color television sets, the source which originally caused the committee to look into radiation, are also in millions of homes. The use and development of laser products are on the increase. And the use of atomic power has grown greatly since we first looked into the area of radiation.

An item in this morning's paper reported on a radiation leak in an atomic powerplant. This afternoon, the House is scheduled to consider a bill which authorizes funds to eliminate "certain radiation hazards in buildings in Grand Junction, Colo."

One of the many ironies of radiation is that it can cause cancer and at the same time it is used for the treatment of cancer.

Our first hearings will deal with an other-than-normal exposure to radiation. We will hear witnesses who were exposed to atomic blasts during the 1950's in Nevada and in the Pacific. And I would like to commend my colleague, Dr. Tim Lee Carter and his staff, for bringing to the committee's attention the facts of the matter dealing with these atomic blasts.

I think that most people understand the dire consequences of massive doses of radiation. But recently there has been a growing controversy on the health effects of long-term, low-level, radiation, and we have not devoted enough attention or resources to this. We hope that these hearings will give us guidance in this important area.

I think Dr. Carter has a statement he would like to make at this time before we call our first witness.

Mr. CARTER. Mr. Chairman, I am pleased that the subcommittee is holding a series of hearings this year on the health and safety aspects of ionizing and nonionizing radiation. As we all know, life is constantly exposed to various sources of electromagnetic radiation, from cosmic rays to X-rays to microwaves.

Over the past decade, human exposure to radiation has increased. It is estimated that, as our population increases the total population dose of ionizing radiation will almost double by the year 2000. Moreover, the longstanding controversy over the biological effects of exposure to low-level ionizing radiation has intensified.

Clearly, it is important that we, who have a responsibility to protect the public health, do all we can to understand as fully as possible both the benefits and the risks of radiation exposure.

Our intererst in this subject derives from several sources. As authors of the 1968 Radiation Control for Health and Safety Act, our subcommittee has responsibility for regulating electronic product radiation. In addition, the Food, Drug, and Cosmetic Act, over which we have jurisdiction, contains authority to regulate radiation found in or used in connection with foods, drugs, cosmetics, and more recently, medical devices. Also, the broad research authorities of the National Institutes of Health and the National Institute for Occupational Safety and Health provide additional resources to study the health and safety issues of radiation exposure. Finally, our subcommittee's authority in the environmental area, coupled with the strengthened mandate which we gave the EPA in last year's Clean Air Act amendments, means we have a strong interest in this field. Thus, from a variety of sources, our subcommittee has an important responsibilty to protect the public from unnecessary exposure to radiation.

In addition to jurisdictional ties, I have a personal interest in examining the health effects of ionizing radiation. A constituent of mine, Mr. Donald Coe, has leukemia which he claims was due to his exposure to radiation at several atomic blasts during 1957 as part of his military service. We shall, of course, be exploring the possible link between leukemia and other cancers, and the Government's testing programs at tomorrow's hearings.

I have a special interest, Mr. Chairman, in this field as a physician. I am sensitive to the need to balance the risks versus the benefits of ionizing radiation. Clearly, there is no simple answer. Virtually any medical procedure for the treatment of human ills poses some degree of hazard to the individual, yet we know of the tremendous benefits and lifesaving potential of diagnostic and therapeutic radiology. We know medical radiology alone accounts for 90 percent of total manmade radiation to which the U.S. population is exposed, and this area will be explored in a future hearing.

The challenge we face is to make the best possible judgments about the risks and benefits of exposure to radiation. Our programs, which are designed to protect the public health, must be based on the most up-to-date knowledge in this area. To address this responsibility we will undertake a thorough review of this complex area in the coming months.

We will begin today with low-level ionizing radiation, and I look forward to hearing from our distinguished witnesses.

Thank you, Mr. Chairman.

Mr. ROGERS. Thank you.

Mr. Ottinger, do you have a statement?

Mr. OTTINGER. No, Mr. Chairman, I don't have a statement, but I assume that our investigation will include the alleged suppression of the report by Dr. Thomas Mancuso on the effects of radiation on the workers at Hanford, Wash.

Mr. ROGERS. Yes. I might advise the gentleman we probably will go into that February 8 and 9.

Mr. OTTINGER. I thank the chairman. I very much appreciate his holding these hearings. I think it's a very important topic.

Mr. ROGERS. I thank the gentleman.

We have three witnesses this afternoon to begin the hearings. I suggest as their names are called each of the witnesses come to the table. We will take individual statements and then have questions. The first witness will be Dr. Karl Z. Morgan, who is one of the most knowledgeable men in our Nation in the area of radiation.

Dr. Morgan worked with the Atomic Energy Commission before retiring from there, and is presently at the Georgia Institute of Technology.

Dr. Morgan, if you could come to the table, we welcome you. It is good to see you again.

The second witness will be Dr. Martin Sperling, senior scientist, Science Applications, Inc., San Diego, Calif.

Doctor, if you could take a place at the table, we welcome you.

And Dr. Arthur Tamplin, who is also a distinguished scientist and is staff scientist at the National Resources Defense Council in Washington. We welcome you.

Your statements will be made a part of the record in full at this point, without objection, and you may proceed in the order your names were called.

So we welcome each of you and appreciate your helpfulness to the committee.

Dr. Morgan, if you would care to begin, we will be pleased to receive your testimony.

STATEMENTS OF KARL Z. MORGAN, PH. D., NEELEY PROFESSOR, SCHOOL OF NUCLEAR ENGINEERING, GEORGIA INSTITUTE OF TECHNOLOGY; ARTHUR TAMPLIN, PH. D., STAFF SCIENTIST, NATIONAL RESOURCES DEFENSE COUNCIL; AND MARTIN SPERLING, PH. D., SENIOR SCIENTIST, SCIENCE APPLICATIONS, INC.

Dr. **MORGAN.** Mr. Chairman, it is a pleasure and an honor to be with you this afternoon.

The topic of my discussion is the significance of human exposure to low-level radiation.

Although in this presentation I will speak only about the effects of ionizing radiation on man, I purposely have not qualified the word "radiation" in the above title in order to remind us that there are other forms of radiation—sonic, ultrasonic, infrasonic, ultraviolet, infrared, microwave, radio frequency, and long wave.

These nonionizing radiations, like ionizing radiation, may be multiplying their presence so rapidly in the human environment that they too are resulting in health hazards in some areas before we are sufficiently aware of the magnitude of the problem. Let us resolve not to repeat with them the mistakes we have made with ionizing radiation by underestimating their risks of chronic damage.

When I began as one of the five first health physicists at the Metallurgical Laboratory at Chicago under Dr. A. H. Compton early in 1943, I was reminded of the suffering and death that had been a retribution to many persons, who through ignorance and carelessness had not shown proper respect for the danger of chronic damage, cancer, associated with excessive exposure to X-rays and radium.

As health physicists and as forerunners of a new profession, for example, 3,400 members of the United States-Canadian Health Physics Society in 1977, we were charged with the responsibility of devoting our new profession to the task of minimizing radiation exposure and making this new industry of atomic energy one of the safest of modern industries in spite of the fact that we would be building nuclear reactors, called piles in those days, that would produce levels of radiation behind thick-walled containment that were many billions of times greater than man had heretofore conceived.

Also, although only one ten-millionth of a gram of radium was the maximum permissible body burden for a radiation workers, there would be hundreds of pounds of plutonium in a reactor, 3 metric tons in a 1,000-MWe LMFBR, and we even then had good reason to believe plutonium would be as radiotoxic or more so as radium.

Looking back over these past 35 years I believe in many ways we have made a remarkable safety record. By contrast with other industries, chemical, coal burning powerplants, ground transportation, et cetera, from their beginning gave very little attention to minimizing associated occupational hazards and environmental problems.

This, however, does not mean we have a perfect record in the nuclear industry, for we have made many mistakes, and only by comparisons with the bad record of other industries does atomic energy have a good record. It should be emphasized also that insofar as unnecessary exposure to ionizing radiation is concerned the finger of guilt should be pointed first toward the medical professions from whence more than 90 percent of our exposure from manmade sources derives. I (1) have shown that this medical exposure could be reduced to 10 percent of its present amount while at the same time improving medical radiography. This is a long neglected area that deserves more attention from all of us.

The problem of control of radiation exposure during the past 35 years has been made especially difficult because each year new evidence has shown that the risk of radiation induced malignancies is greater than we had thought the year before, and from time to time there have been quantum drops in the levels of maximum permissible exposure.

During the first half of this 35 years of the atomic age, 1942-60, a large number of scientists, perhaps most who were knowledgeable in health physics and radiobiology, accepted the threshold hypothesis or the theory that there is a safe level of exposure to ionizing radiation, and as long as a person does not exceed this threshold or safe level no harm will result or the radiation damage on the average will be repaired as fast as it is produced.

During the last half of this period, 1960 to the present, an overwhelming amount of data have been accumulated that show there is no safe level of exposure and no dose of radiation can be so low that the risk of it causing a malignancy is zero.

The question before us at this meeting today, therefore, is not, "Is there a risk from low level exposure?" or, "What is a safe level of exposure?" Rather it is, "How great is this risk?" or, "How large may a particular radiation risk be before it exceeds the expected benefits?"

One of the problems we face today is that many scientists had accepted the threshold hypothesis as a cardinal law and had lived with this hypothesis so long that they became staid or petrified in their thinking, and now they cannot believe or accept the fact that the threshold hypothesis was wrong and it cannot be applied to the induction of malignancies by radiation.

It is obvious to all scientists in this field as well as to the diehards for the threshold hypothesis that at least for some types of radiation damage and for some kinds of radiation exposure there is some repair going on in the body of the radiation damage, but the diehards do not seem willing or able to accept the preponderance of evidence that there is never complete repair of radiation damage in the practical case since even at very low exposure there are many thousands of interactions of the radiation with cells of the human body, for example, 1 rad of X-rays of 1 MeV energy corresponds to 2.2 billion photons per cm^2 acting on the body, which would be about 18 billion per square inch acting over the body.

It is inconceivable that all the billions of irradiated and damaged cells would be repaired. There are undoubtedly many mechanisms of radiation damage that contribute to the development of a malignancy following an exposure to radiation; perhaps the most significant damage from a low exposure would be to the nucleus of one of the billions of cells that are irradiated.

There are 46 chromosomes in the nucleus of each normal somatic cell of the human body and along each chromosome is coded millions of bits of information like an immense library which enables or instructs the cell to function properly and to divide at the appropriate time.

When radiation passes through the human body, four principal things can happen:

(1) The radiation passes through the cell without producing any damage;

(2) The radiation kills the cell or renders it incapable of cell division;

(3) The radiation damages the cell such that the damage is repaired adequately; and

(4) A very improbable event, the cell is damaged such that it survives and multiplies in its perturbated form over a period of years, 5 to 70 years, in forming a clone of cells that eventually is diagnosed as a malignancy.

It is only this last event that concerns us here with somatic damage from low level exposure. It seems obvious that if this ideology or a similar series of events leads to the development of a malignancy, there can be no dose so low that the risk is zero. Thus the risk of induction of cancer from radiation exposure increases more or less with the increase or accumulation of radiation exposure, and the risk is simply one of chance, just the same as the risk or chance of an accident each time we take an automobile trip.

Our analogy would be complete if instead of a broken rib at the time of an automobile accident that this accident could cause our death from cancer at some subsequent period, say 10 to 50 years later.

Dr. Philip Burch (2) has shown, for example, that the final onset of a malignancy may require a series of three successive events, and a certain type of leukemia may require as many as three successive events, like throwing three electrical switches which are connected in series.

Thus, for example, one switch may be thrown genetically so that if one twin dies of a particular type of leukemia, one switch thrown genetically, the other twin has a high probability of eventually suffering similar consequences. Some of these switches may be thrown by viruses, bacteria, chemicals, mechanical insults, or by radiation, and when one of these agents throws its switch in a cell of the body, it seems to pave the way or make it easier for radiation to throw its switch in this cell.

Thus, the studies of Dr. Bross (3, 4) have shown that children age 1 to 4 with allergic diseases such as asthma or hives have a 300 to 400 percent increased risk of dying of leukemia compared with other children, as allergic diseases throw one switch.

Children who received in utero diagnostic X-ray exposure have a 40 to 50 percent increase in risk of dying of leukemia, in confirmation of the extensive studies in the United Kingdom conducted by Drs. Alice Stewart and George Kneal (5), while children with two switches thrown, i.e. in utero exposure and later developing a virus disease, have a 5,000-percent increase in risk of dying of leukemia.

Studies of Stewart and Kneal (5), B. MacMahon (6), BEIR Committee (7) and Bross (3, 4) as well as those of many other researches show that children have a higher risk of dying of radiation induced leukemia than do middle-aged persons. Also it has been shown by others, for example Hempelmann et al. (8), Albert et al. (9), Silverman and Hoffman (10, 11), etc., that radiation-induced thyroid carcinoma presents a higher risk in children than in an adult population. There are studies also which indicate women have a much higher risk of certain types of radiation-induced malignancies than do men and that older and younger men (see report of Mancuso, Stewart, and Kneal (12) on increased malignancies among Hanford radiation workers) have a higher risk of radiation induced malignancies than do men of middle age.

After publication of the studies of E. Saenger and E. A. Tompkins (13), supported by the Bureau of Radiological Health, which was interpreted to show that there is no risk of thyroid carcinoma from exposure of young people to 131I, the BEIR Committee (7) wisely pointed out that the conclusions of Saenger and Thompkins that there is no increased cancer risk cannot be justified by their failure to find a clear-cut increase in thyroid carcinoma among hyperthyroid patients treated with 131I.

I believe their failure to observe an increased cancer risk can be explained in several ways, two of which are the followup period was too short, and high doses produce cell sterilization or destruction of the thyroid cells that are likely targets to develop a malignancy without seriously damaging extrathyroid tissue.

Hempelmann (8), Modan, et al. (10), and many others have shown that radiation exposure to the thyroid does increase the risk of thyroid carcinoma at low doses, at least down to 6.5 rad, and that the risk seems to increase linearly with the magnitude of the dose.

Incidentally, Dr. E. B. Lewis (14) of California pointed out that after examining this data of Saenger and Thompkins (13), et al., he observed that they failed to note there was a significant increase in leukemia among persons between ages 50 and 79 who received the 131I treatments. This recalls the fact that the Mancuso, Stewart, Kneal report found a higher instance of cancer among its Hanford workers who were in the older age group.

Dr. Lewis (14) went on to note also that the statistical method used by Tompkins "lacks the power to detect even large differences between the two groups." Parenthetically, I might remark that we hear the Hanford study of Mancuso, Stewart, and Kneal was moved recently by ERDA in-house to Oak Ridge, where Dr. Thompkins will be responsible for the statistical method.

It will be interesting to see whether or not this Oak Ridge team will confirm the findings of Mancuso, Stewart, and Kneal that the low level of exposures at Hanford, much less than the maximum permissible occupational levels for workers, resulted in a significant increase in the number of employees dying of cancer.

As stated above, the cancer risk from exposure to ionizing radiation is certainly much greater than was thought to be the case some years ago. During the 29 years I was director of the Health Physics Division at Oak Ridge National Laboratory, my division worked closely with the Atomic Bomb Casualty Commission, ABCC, and was responsible for determining the radiation dose received by the survivors of the bombings at Hiroshima and Nagasaki, Japan. Thus, I have a great interest in the success of these studies.

In the early period, following the deaths from radiation sickness that occurred shortly after the atomic explosions, it appeared to many scientists the principal chronic risk from the radiation exposure was only an excess of cases of leukemia. The number of excess leukemias reached a peak about 6 years after the bombing, and since then it has slowly declined. During this period many persons jumped to the conclusion that the only chronic risk among these survivors was that of developing leukemia. Unfortunately, however, as the study of these survivors has continued and extended further into the incubation periods of the various malignancies, other forms of cancer, bone, breast, lung, have shown a significant increase above the controls. Probably with the passage of time we will find that this exposure has resulted in an increase of statistical significance in many or most kinds of malignancies that are common among human populations.

During the first half of this atomic age, 1942-60, almost everyone assumed that the genetic risk from low level radiation exposure far exceeded the risks of chronic somatic damage such as cancer or life shortening. During the last half of the atomic age, however, it has become increasingly clear that this assumption, like the threshold hypothesis, is unwarranted and untenable.

The BEIR (7) committee pointed out:

> Until recently, it has been taken for granted that genetic risks from exposure of populations to ionizing radiation near background levels were of much greater import than were somatic risks. However, this assumption can no longer be made if linear nonthreshold relationships are accepted as a basis for estimating cancer risks.

The committee then went on to supply many pages of data, most of which lend strong support of the linear hypothesis. In 1971 the International Commission on Radiological Protection (20) made a similar observation: "It could be concluded that the ratio of somatic to genetic effects after a given exposure is 60 times greater than was thought 15 years ago."

This discussion, however, is not to depreciate the seriousness of genetic risks from exposure to ionizing radiation but rather to emphasize that the scientific community was rather smug 15 years ago, as some scientists still are today, in its belief that somatic risk is far less than genetic risk, and somatic risk is almost negligible at low doses, but now most of us realize the risk of inducing cancer at low doses of radiation is far greater than we once thought it to be, and it may be as great or greater for the human race than genetic risk.

Nevertheless, I wish here to pause and sound a warning that I am sure my long time friend and associate, the geneticist, Dr. H. J. Muller, would urge me to make were he alive today, namely the BEIR report only treated the long-term recessive mutation question in a superficial way, and it may well be that many and perhaps most of our human diseases are related to a genetic factor and especially to the 10,000 nonvisible or "small" mutations that result per visible mutation that we can observe.

It may be that in the long run Muller's small mutations that result in such things as lack of vigor, susceptibility to disease, a slight reduction in mentality and physique, et cetera, will be a greater burden to society than the easily identifiable dominant mutations, because such mutations are eliminated so slowly from the gene pool.

As stated above, there has been a number of reductions in the permissible exposure levels for occupational workers and for members of the public during the past 35 years, even though many of those in organizations which set the standards at national—National Council on Radiation Protection—and international levels, radiologists, nuclear energy workers, et cetera, would never admit there was any real need for greater conservatism.

Table 1 [see p. 13] indicates some of the quantum drops in permissible exposure levels during the past 35 years. The occupational maximum permissible exposure level has dropped by a factor of 10, and the level for members of the public by a factor of 300. The occupational maximum permissible exposure level has dropped by a factor of 10, and the level of members of the public by a factor of 300.

Our concern for the environment and the concentrations of radionuclides in air, water, and food, likewise have undergone evolutionary jumps. For example, in 1943–44 I was faced with setting the maximum permissible concentration of radioactive material in White Oak Lake which impounds the liquid radioactive waste discharged from Oak Ridge National Laboratory.

The only standard I had to go by was the NCRP value of 0.1R rad because this was before lower levels were set for the population at large. Some of my engineering associates at ORNL were very much provoked at my conservatism, and they insisted I set the level at 100 rad because of the rather unlikely event persons would drink or swim in this water. Signs and fences as well as the turbidity of the water discouraged fishing and swimming in White Oak Lake.

Today we recognize this higher level would have been over 6 million times the value we probably would use today. I stuck to my guns, however, and used the 0.1 rad instead of 100 rad, but in the context of today's standards I deserve no praise because this value is still 6,000 what some would insist on our using today, even though shortly below where White Oak Lake empties into the Clinch River and leaves the reservation it is diluted by a factor of over 100,000.

Mr. **Rogers**. May I interrupt at this point?

There is a call for a vote on the floor of the House. So the committee will stand in recess for 10 minutes.

[Brief recess.]

Mr. **Rogers**. The subcomittee will come to order, please.

Dr. Morgan, you may continue, please.

Dr. **Morgan**. Thank you, Mr. Chairman.

Much of what has been said about the risks of exposure to low levels of ionizing radiation would have considerably less weight if it could be shown that although the linear hypothesis holds at intermediate to high levels of exposure it provides a very large element of conservatism at low doses and dose rates. I am amazed and appalled at the large number of scientists (mostly associated in some way with ERDA—now DOE) and radiologists who, in spite of an overwhelming amount of data supporting the linear hypothesis at low doses, are still saying we have no human exposure data at low doses and that there is a large factor of conservatism in this hypothesis when it is applied to low doses. I take the opposite position, namely, that we have a large amount of such data. Much of it is human exposure data showing a statistically significant increase in a number of types of malignancies as a consequence of exposure to low doses of radiation, and the number of malignancies increases progressively as the dose accumulates. These doses in some cases are considerably lower than the present levels of maximum permissible occupational exposure. In fact, I have gone further; I (17) and many others (25, 26, 27) have shown that in some cases, for example, internal exposure to plutonium, the linear hypothesis is nonconservative and the present maximum permissible concentration values for plutonium and transplutonic elements (21) should be reduced considerably. See reference (17) attached as an appendix to this paper. [See p. 17.]

It has been shown that the leukemic risk increases linearly with the dose at least down to 0.8 rad, and the thyroid cancer risk increases linearly with the dose at least down to 6.5 rad. [See table 2, p. 14.] It must be pointed out that these doses are not the doses below which the linear hypothesis breaks down but the lowest points on the human exposure curves for these two malignancies, and we have every reason to believe the linearity of these curves continues on down to zero dose and that there is a similar linearity for other types of cancer that simply have a longer incubation period. It should be emphasized also that this 0.8 rad is only 5 percent of the 15 rad permitted each year to the active bone marrow of the radiation worker and that the 6.5 rad is only 22 percent of the 30 rad permitted each year to his thyroids. If a million children each received one rad from in utero exposure, we would expect from 300 to 3,000 leukemias, depending upon whether or not the child had certain respiratory diseases, some of which, as indicated by Bross (3, 4), act synergistically with radiation exposure. There is not as much low level dose data on adults as for children, but their risk seems not to be less by more than a factor of three. Furthermore, studies of Stewart (5, 22), MacMahon (6, 23), and many others indicate that following in utero exposure the incidence of focal cancers, such as cancers to the central nervous system, are about the same as that of leukemia, such that the numbers that we have just quoted might be, for example, 6,000 cancers per million children exposed to only 1 rad if they also had certain respiratory diseases.

In 1970, Jablon and Kato (24) pointed out that their data on the survivors of the atomic bombings who were exposed in utero do not support the findings of Stewart (5, 22), MacMahon (6, 23), and others. They indicated that on the basis of findings of Stewart and Kneale and upon the corresponding linear hypothesis they should expect 36.9 excess cancers in the Japanese group during 10 years following exposure, but they only observed one cancer in this group. As a consequence, many persons—who were desperately trying to disprove the linear hypothesis and show low level exposure is harmless) were quick to proclaim that there was something wrong with the retrospective studies of cancer induction by diagnostic in utero X-ray as reported by Stewart, MacMahon, and others and that now we could relax. Unfortunately—for in utero exposed children—this was not the case. Dr. Stewart and a number of other writers (1, 17, 19, 28, 29, 30) have published reports which give strong support of the studies of Stewart, MacMahon, et cetera, of cancer induction by diagnostic in utero X-ray such that there is now little doubt the Japanese studies greatly underestimated this cancer risk. In fact, Jablon and Kato (24, 7), in their original publication, gave an explanation that now seems to be one of the principal reasons they observed such an unusually low cancer rate among children who had received in utero exposure at the time of the bombing. They said: "Conceivably such a result might follow if there were an excessive spontaneous abortion rate for fetuses by large doses."

Thus, what I am saying, then, is if at the time of the exposure there happened to have been a large number of abortions or deaths of young children that this would upset the data and would naturally give data as they found.

Thus, the fetuses which were more likely to have developed into cases of radiation induced leukemia received such high doses that they did not survive to become statistics. In fact, the record indicates there was an unusually high incidence of abortions and rate of infant mortality following the atomic bombings. Many studies (31) have shown that during periods of stress and community disasters it is the infants and young children that suffer the most. It is known that during such periods of suffering and unrest, incipient cancers can easily be mistaken for acute infections. Also, it seems likely that the Japanese control group may have had a greater cancer risk than normal.

In conclusion, I have given a very simplified picture of events that probably lead to the production of cancer in humans and from such a theory as well as a large amount of data on low level human exposure to ionizing radiation it seems evident that all forms of cancer can be caused by low level exposure, that the linear hypothesis when applied to low level exposure is not conservative and thus there can be no dose so low that the risk of radiation induced cancer is zero. In the case of radiation exposure the risk is simply an increase in risk that the person will develop cancer, but this cancer may not develop and be recognized until 5, 20 or 50 years later. In comparison with other industries, I believe the nuclear energy has a remarkably safe record. However, I believe it has many black spots on this record, such as, for example, to mention a few, the West Valley, N.Y. reprocessing plant and the Kerr-McGee fabrication plant near Oklahoma City, which broke every conceivable health physics rule of good radiation safety, or I might mention the environmental pollution of Rocky Flats with plutonium, or the practice of burning out temporary employees on some of the hot operations. This I consider inexcusable.

The steam generators of the pressurized water reactors have continued to account for high occupational exposure in some of the nuclear power plants, and the solution is not to hire temporary employees to divide up the dose, but rather to correct the source of this trouble.

Other industries are not as innocent. For example, we recall exposures from the shoe-fitting machines, radium dial watches, smoke detectors today that contain americium-241 and radium-226, the color TV problem, industrial radiography, and we could go on and on. The shadow of improper concern for or understanding of radiation risks also falls on the military with its exposure of young men on Test Smoky. The worst offender, however, has been the medical profession. For example, after years of effort we finally outlawed mass chest X-ray programs only to have the profession get underway a mass mammography program, and then we come to the dentists. They are better only in that the dose they deliver to the population is less than that of medical diagnosis, but their failure to take radiation protection measures (1) has, without question, increased the significance of the number of CNS tumors, thyroid carcinomas, and leukemias among our population.

I ask, then, a few questions. Is it a wonder that the cancer rate continues to rise in the United States?

Another: When will our Government agencies that are responsible for the recognition, prevention and control of radiation risks from low level exposure to ionizing radiation awaken to their tasks of serving the people?

I thank you, Mr. Chairman.

[Testimony resumes on p. 21.]

[Attachments to Dr. Morgan's prepared statement follow:]

TABLE 1. CHANGES IN LEVELS OF PERMISSIBLE EXPOSURE TO IONIZING RADIATION

Recommended Values		Comments
FOR RADIATION WORKERS:		
0.1 erythema dose/y (~1R/wk for 200 kV x-ray)	52 R/y	Recommended by A. Mutscheller and R. M. Sievent in 1925. This was recommended by ICRP in 1934 and used world-wide until 1950.
0.1 R/day (or 0.5 R/wk)	36 R/y	Recommended by NCRP on March 17, 1934.
0.3 rem/wk	15 rem/y	Recommended by NCRP on March 7, 1949 and ICRP in July, 1950 for total body exposure.
5 rem/y	5 rem/y	Recommended by ICRP in April, 1956 and NCRP on January 8, 1957 for total body exposure.
FOR MEMBERS OF THE PUBLIC:		
0.03 rem/wk	1.5 rem/y	Suggested by NCRP in September, 1952 for any body organ.
0.5 rem/y	0.5 rem/y	Suggested by NCRP on April 15, 1958 and by ICRP in July, 1959 for gonads or total body.
5 rem/30 y	0.17 rem/y	Suggested by ICRP on September 9, 1958 for gonads or total body.
25 mrem/y	0.025 rem/y	Suggested by USEPA on January 13, 1977 for any body organ except thyroid
5 mrem/y	0.005 rem/y	Suggested by USERDA in 1974 for persons living near a nuclear power plant.

NOTE: (1) 1 R ≈ 0.88 rem.
(2) See Reference 16 for additional information.

TABLE 2. CANCER RISK AND KNOWN RANGE OF LINEARITY

Linearity of Dose Down To:	Risk Per Person Per Rad	Comments	References
<10 Rad	$0.3 - 1.0 \times 10^{-4}\ell$ $0.5 - 1.7 \times 10^{-4}C$	Hiroshima & Nagasaki atom bomb survivors	7, 18, 19, 20
Av. 370 Rad	$0.2 - 0.3 \times 10^{-4}\ell$	Ankylosing spondylites patients	7, 20
0.2 - 0.8 Rad	$3 \times 10^{-4}\ell$ $6 \times 10^{-4}C$	Pelvimetry Exposures - Stewart & Kneale	5, 22
~ 1.0 Rad	$3 - 30 \times 10^{-4}\ell$	Pelvimetry Exposures - Bross et al	3, 4
20 Rad	$0.5 - 1.1 \times 10^{-4}T$	X-Ray Therapy - Hempelmann	8
6.5 Rad	$1.2 \times 10^{-4}T$	X-Ray for Tinea Capitis - Modan et al	10

ℓ = Leukemia risk/person. rad
C = Total cancer risk/person. rad
T = Thyroid cancer risk/person. rad

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THE LINEAR HYPOTHESIS OF RADIATION DAMAGE APPEARS TO BE NON-CONSERVATIVE IN MANY CASES

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The purpose of this paper is to express a word of caution to those members of the International Radiation Protection Association (IRPA) and to members of the International Commission on Radiological Protection who seem to believe our present levels of maximum permissible dose (MPD) for occupational workers and dose limits (DL) for members of the public are unnecessarily low and should be increased. At the same time, I would caution persons in the United States who are advocating that present levels should be reduced by an order of magnitude. Likewise, I wish to discourage some members of IRPA from repeating their claim that the linear hypothesis, upon which we base our present radiation protection standards, is overly conservative.

I believe present values of MPD are satisfactory, but only because in industry and in the vast majority of nuclear energy programs these values are considered as upper limits so that on the average exposure to radiation of workers does not exceed 10% of MPD. This practice has developed as a result of the principle of ALARA (exposures As Low As Reasonably Achievable). Were the day to come when occupational exposures are averaging 50 to 80% of the MPD, I would be first to urge a reduction in present MPD. In this connection, I deplore the fact that some nuclear power plants and fuel reprocessing plants in the United States have ignored the principle of ALERA, have adopted the practice of "burning out" employees by using "expendable" temporary employees, and have exceeded 1000 man-rem/y at some of the power plants. It is unfortunate, also, that for the most part the medical profession ignores the principles of ALARA for patient exposures. I do not believe, however, that the solution to these problems is to lower MPD and DL by an order of magnitude, for then many health physicists would feel obligated to reduce exposures to 1% or less of our present values; this could deprive us some great benefits that can be expected from proper use of ionizing radiation. For example, I believe present average occupational exposure of 5 to 10% MPD = 250 to 500 mrem/y to total body does not present an unreasonable or unusual occupational risk. We might expect this risk to be of the order of $500 \times 10^{-3} \times 3 \times 10^{-4}$ c/rem $\times$ 40 y = 6 chances of cancer from occupational exposure per 1000 radiation workers. The long range genetic risk would be about the same magnitude as somatic risks, and I consider this acceptable in comparison with risks in safe occupations. However, I would consider a 6% cancer plus a 6% genetic risk too high. I feel the same about not changing population DL so long as present practice limits this on the average to less than 10%.

With the demise of the treshold hypothesis, the linear hypothesis has gained acceptance as the basis for setting radiation protection standards and this has led some health physicists to decry its use and make incorrect claims: 1) The linear hypothesis holds only in the high dose range, 2) There are no human exposure data indicating radiation damage due to low doses (ionizing or non-ionizing), and 3) The linear hypothesis is always overly conservative in the low dose range.

Regarding claim number 1, just the opposite is true. In the high dose range the linear hypothesis always breaks down because one cannot cause deaths in over 100% of exposed population and a maximum effect is reached at some intermediate dose because at higher doses the animals do not survive long enough to die of effects under study. It is true that for low LET radiation the linear hypothesis is often conservative for low doses administered to animals because time is allowed for cell repair and cell replacement. However, studies of production of leukemia as a result of in uteral x-ray exposure[1,2], and exposure to young people[3,4,5], as well as some studies on old animals, suggest that very young and very old members of a population are radiosensitive and the linear hypothesis, as applied to them, is non-conservative even for low LET radiation. Many evaluations of[6,7,8,9,10,11] cancer production from high LET radiation of humans as a consequence of body burdens of radium indicate that if there is departure from the linear hypothesis in the low dose range it is in the direction of more cancers produced per rad at low doses than at high doses and that protraction[12] of time over which dose from ^{224}Ra is delivered to patients increases rather than decreases the risk of cancer.

Regarding claim number 2, there are many publications reporting harmful effects of low exposures to both ionizing[1,2,3,4] and non-ionizing[13,14] radiations, so I can only conclude those who repeatedly claim such data do not exist must completely discount the validity of such studies. I do not agree that findings of these studies can be ignored and believe the validity of some of the findings is sufficiently substantiated that we must take seriously enforcement of the principle of ALARA.

It is easy to understand why there are adherents to claim 3, and why many disciples of the old threshold hypothesis are reluctant to abandon belief that if one does not exceed a threshold dose there is no risk of radiation damage, or if the dose is kept below a threshold value, the rate of repair can keep pace with the rate of damage produced. It is true in many cases, and especially for low LET radiation, the rate of repair may keep up with the rate of damage. In some cases also the average incubation period for certain malignancies may be longer than expected remaining life. However, we should not take too much comfort in such observations because each person differs in response to radiation such that the only safe assumption is that no dose can be so low that the probability of radiation damage is zero.

Generally accepted theories of damage lead to the conclusion that a given type of radiation damage from a given type of exposure is simply a matter of chance. By this we mean that of the millions of photons and alpha particles that loose energy in an organ of our body each day; there is always the remote chance that one of these will damage a cell in such a way that it survives, but only to reproduce itself in its perturbated form and that in time there developes a clone of perturbated cells which is identified as a malignancy. The fact that there is no "safe" level of radiation exposure is not a unique type of risk--we all know, for example, there is never a trip in a Paris taxi that is "safe."

Now that we have discarded the threshold hypothesis, let us summarize reasons why in some cases use of the linear hypothesis to estimate risk at low doses is not a conservative assumption as follows:

1. Overkill at high doses. Most estimates of risk from radiation exposure are based on linear extrapolation of effects at high doses down to zero dose. Often with such extrapolation insufficient account is taken of overkill and that in no case can more than 100% of the animals be killed by radiation. Sometimes one simply determines the best least-squares line which will pass through the (0,0) point. Some points used in determining the slope of this line may be on the bend of the curve where the animals are injured by large doses of radiation such that they do not survive long enough to die of the effect under study.
2. Short follow-up period of human studies. Most studies[15] of effects

of ionizing radiation on man extend over only a small fraction o. his life span. If one determines the slope of curve of thyroid carcinoma risk vs x-ray dose and the followup period is only 7 years; studies of population until all have died would increase the slope of curve and risk estimate.

3. Fractional life span animal studies. Sometimes comparisons are made between fetal damage during first trimester of a mouse and damage we might expect during first trimester of a woman, or a comparison is made over life of animals having a life span of 20 years with expected effects over life span of man. Since in many cases damage from radiation exposure may relate more closely to what happens in a given number of years following exposure rather than what happens over a certain fraction of the animals' life span, such extrapolations to man can only lead to underestimates of risk.
4. Radiosensitivity differs among animal species. Many studies have emphasized the risk of extrapolating data on effects of radiation exposure from one animal to another or to man. Differences in metabolism, turnover rate, GI tract uptake, skin perspiration, blood circulation, mitotic index, etc., can have a marked effect on animal response to a given dose of ionizing or non-ionizing radiation. An examination of data leads me to conclude that more often than not this kind of extrapolation to man results in an underestimation of risks.
5. Heterogeneity of human population. The vast majority of studies of effects of radiation exposure are carried out with imbred animals. Radiation ecology programs must be extended to animals in the wild if we are to simulate effects we expect from low doses to human populations. Studies of Bross[16] have indicated that risk of leukemia as a consequence of in utero x-ray exposure increases by 5000% if the child had diseases such as asthma, hives, eczema, allergy, pneumonia, dysentary or rheumatic fever compared with the child without this exposure and history of such disease. In accessing population risk of low levels of exposure we need to know dose response for young and old, male and female, sick and well, fat and slim, the person of average eating habits and the one with peculiar eating habits, etc. When we have such data, our estimates of risk from low level exposure will increase.
6. Cell sterilization. It is well established that as old age is approached, the percent of abnormal cells in the body increases; for example, the percent of chromosomal aberrated cells increases with age of an animal. It is commonly believed that some types of malignancies develop as a result of a series of changes that take place in the 46 chromosomes that comprise the nucleus of a normal somatic cell in man. Sometimes certain of these changes may be the result of genetic mutation conveyed from one's parents. Thus, we have a scattering of cells and clones of cells which have one or more abnormalities, and may present a much larger cross-section for the production of a malignancy than a normal cell. It may be that the etiology of cancer is similar to throwing of a series of switches such that cancer cannot develop unless all switches are thrown. Children born in a family with one of "switches" thrown genetically have a higher cancer risk than average children and persons who have been exposed to higher levels of carcinogens have more high cross-section cells that are likely targets for the origin of a malignancy. When studies are conducted on animals exposed to high doses of radiation, cell sterilization may take place such that many cells that are likely targets for development of a malignancy are destroyed. Thus, such data points at high exposure levels would tend to reduce the slope of the curve that is extrapolated to zero dose and may result in an underestimate of risk at low levels of exposure.

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Mr. ROGERS. Thank you very much, Dr. Morgan, for your most helpful statement. It was really an excellent statement, and has given the committee a clear understanding of the problems we face.

I think we will have the other statements, and then the questioning, if there is no objection from the witnesses. Perhaps it would be better for Dr. Tamplin to speak next, since I think Dr. Sperling will talk more on Smoky.

So, Dr. Tamplin, if you could proceed, we will be glad to receive your statement.

STATEMENT OF ARTHUR TAMPLIN, PH. D.

Dr. TAMPLIN. I didn't prepare a statement just for this particular hearing. What I did was submit for the record a paper which I had prepared in August 1977 on the biological effects of radiation, in which I indicate that the present estimate of the biological effects of radiation is at least 10 times worse than was estimated just as recently as 1972. [See p. 24.]

This, of course, as Dr. Morgan indicated, has been the nature of the biological data on the effects of radiation.

As more and more time has gone by, the data indicates that the risks were much greater than we had estimated previously.

In 1969, my colleague, John Gofman, and I became very concerned about the radiation exposure standards, both for the population at large and for workers. At that time, we were at the Lawrence Radiation Laboratory in Livermore, and we made estimates of what the biological effects of radiation were, which set off a roar of protest among the Atomic Energy Commission and the nuclear power industry.

Subsequent to that, the National Academy of Sciences BEIR committee was convened, and their report, which was called the BEIR report, was published in November 1972. Since that time, in all the environmental statements, and so forth, that report has formed the basis for estimating the biological effects of radiation.

Now, when Gofman and I estimated the effects of radiation, we used the concept which is called the doubling dose, and what this meant was that dose of radiation which would double the natural incidence of cancer. We estimated that this doubling dose was 50 rads. Now, the BEIR committee, in their 1972 report, estimated that this doubling dose was 200 rads, some four times larger than ours.

In this paper I point out that there subsequently have been a number of studies which have suggested that approach, using the linear extrapolation, was not necessarily conservative. Probably the most significant report to come out has just come out recently, which is the Mancuso, Stewart, and Kneale report, and it is this particular report which demonstrates very strongly that the BEIR report estimates of the cancer induction by radiation were too low by the factor of 10.

In the Mancuso report the doubling dose for cancer induction is approximately 10 rads. That is a factor of 20 below what was used by the BEIR committee and, much to my surprise, it is even a factor of five below what Gofman and I used.

Subsequently, I have come across two other papers which, when I update this particular report, strongly support the Mancuso study. One of them is a paper by Pochin [see p. 40] who is a scientist in England. In the Japanese survivors of the atomic bomb there was a group of individuals who received low dosage of radiation; this is zero to 9 rad. And quite often in making comparisons of the Japanese study, they would use this low-dose group as the control group indicating that they didn't anticipate any cancers to be induced in that group.

Pochin, in this particular paper, looked at that particular group and found that actually the leukemia rate had almost doubled in this zero to 9 group. In other words, he is also coming out with an estimate of a doubling dose in the vicinity of 10 rad, not the 200 rad used in the BEIR report.

Also, there is a paper which is to be published, which was prepared by Dr. Rotblat [see p. 43] who looked at another group of people in Japan, and these are the individuals who went into Hiroshima and Nagasaki after the bombing to do the rescue work and to find their relatives. These people were also exposed to low doses of radiation. And his estimate, again by looking at leukemia, is that the BEIR committee's estimate of the doubling dose for cancer is 10 times too large.

So what has been happening since the 1972 BEIR report was published is that the new data which has accumulated on the biological effects of radiation is demonstrating quite strongly that the BEIR committee's estimates were too low by a factor of 10. And also, as Dr. Morgan says, they are indicating that this linear extrapolation which was used is not conservative. It actually underestimated the effects of low-dose radiation.

I think the thing that this committee should recognize about these new data which are available today is that we are now talking about doses which can double the incidence of cancer that are small, say, compared to the allowable occupational exposure. A worker in a nuclear power industry could receive this doubling dose in 1 year. If he is 20 years old, he could receive a dose of 12 rad in 1 year. In other words, a doubling dose.

Also, this doubling dose is such that if one looks, for example, at the soldiers who were exposed in these training exercises at Nevada, you are talking about doses which suggest very strongly that the balance of probabilities would indicate that the cancers which are developing in these soldiers were the result of their exposure on these training exercises.

I would anticipate that both the nuclear power industry and the Veterans Administration are going to find themselves involved in a considerable number of lawsuits in order to rectify this situation. The nuclear power industry, I am sure, is going to have to pay a large number of claims for occupational illness because of the workers who develop cancer.

It has always been claimed by the nuclear power industry that no one has ever been shown to have died of cancer as a result of his occupational exposure. Well, that isn't true any more. A case was decided in England just a little over a month ago, and culpability was admitted by the British Nuclear Fuels Ltd. They admitted it as part of the court order.

So we now have the first case of an occupational exposure leading to cancer, and I might say that one of the strong points in arguing that case was the Mancuso, Stewart, and Kneale report, so I would anticipate that a large number of these will occur in the United States.

Thank you.

Mr. ROGERS. Thank you very much, Dr. Tamplin.

I might ask if you would place in the record the various studies to which you have referred to. I think you have them with you, or, if not, if you could furnish them for the record.

Dr. TAMPLIN. I can; certainly.

Mr. ROGERS. And also any information you have on the lawsuit in England which shows the first connection with a death to low level radiation from atomic plants.

Dr. TAMPLIN. Yes. I have the joint statement that was read before the court in England.

Mr. ROGERS. I think this would be helpful for the committee. Without objection, they will be made a part of the record at this point.

[Testimony resumes on p. 50.]

[The papers referred to follow:]

THE BIOLOGICAL EFFECTS OF RADIATION: TEN TIMES WORSE THAN ESTIMATED

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ABSTRACT

The latest biological evidence indicates that the estimates of the biological effects of radiation made only five years ago, both for cancer induction and genetic effects, are too low by at least a factor of ten. Among the most critical data is that collected on the workers at the U.S. Hanford facility. This data, to the great surprise of the experts, demonstrates an important and significant increase in the cancer deaths for the workers. All the evidence indicates that workers' exposures should be reduced tenfold. Because of this new information, the nuclear industry should anticipate a number of lawsuits brought by workers who develop cancer.

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1. Introductory Remarks

Radioactivity is a property possessed by some isotopes of the various chemical elements. Tritium, for example, is the radioactive isotope of the element hydrogen. All isotopes of plutonium are radioactive. This property of radioactivity causes the nucleus of the isotope to undergo spontaneous disintegration. In this process, energy is liberated and the disintegration generally results in the formation of a new nuclide (isotope of a different element). The energy is released in the form of radiation, either as electromagnetic waves (X-rays or gamma rays) or as particle radiation (beta or alpha particles). This radiation is called ionizing radiation because as it passes through matter, it is capable of ejecting electrons from atoms and thereby producing ions.

As the radiation is passing through human tissue and producing ions, it is actually transferring its energy to the cells in the tissue. The amount of energy transferred in one of these ionizing reactions is sufficient to bring about chemical changes in the molecules of the cells and thereby produce an abnormal or damaged cell. Such radiation injury to the cells can and does result in the induction of cancer in irradiated tissue. If these chemical changes take place in the germ cells of the gonads, they ld result in altered genes or chromosomes which could then be passed on to and produce genetic defects in future generations. If the radiation dosage is large, so many cells will be damaged that the radiation can be lethal.

The concern over the release of radioactivity to the environment stems from this knowledge that radiation is harmful to man. At high dosages such as could occur following a major accident, the radiation can be lethal. At lower dosages, radiation can induce cancer in the irradiated individuals and induce damage in their genetic material that could be transferred to their offspring and to future generations. Moreover, the range of concern over low dosage effects extends to those encountered in the anticipated day-to-day occupational exposure of employees and releases of radioactivity from the facilities of the nuclear power industry that result in exposure of the public-at-large and the medical uses of X-rays and radiation.

There is no safe level of radiation exposure. The United States National Academy of Sciences, National Research Council, Committee on the Biological Effects of Ionizing Radiation, had this to say about the concept of a safe or threshold dosage of radiation:[1/]

> There is no sufficient theory of radiation carcinogenisis from which the concept can be deduced, and an empirical demonstration has not been made.

Although it did not state it in such explicit terminology, the NAS BIER Committee came to the same conclusions with respect to the genetic effects of radiation.[2/] The International Commission

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[1/] NAS BIER Report, Report of the National Academy of Sciences, National Research Council, Committee on the Biological Effects of Ionizing Radiation, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," Washington, D.C., November, 1972, p. 95.

Ibid, pp. 64-65.

... Radiological Protection has stated:[3]

> It seems unlikely that the dose-response for any kind of genetic effect has any sort of threshold; the underlying mechanism for genetic change is molecular.

Thus, both experimental data and theoretical considerations indicate that any amount of radiation, no matter how small, must be considered as being harmful to man. Consequently, we must be concerned about the smallest radiation exposures and releases of radioactivity from the nuclear power industry.

The BIER Report of the NAS Committee presents the most recent estimates of biological effects of radiation. These estimates are based upon the linear hypothesis. This hypothesis assumes that in the low dose range (dosages below which direct experimental evidence is available), the effects are directly proportional to the dose. This implies that a dose of 1 rem to 1 million people (1,000,000 man-rem) will result in the same quantitative effect such as the number of induced cancers as would a dose of 10 rem given to 100,000 people (this is also 10 X 100,000 or 1,000,000 man-rem). The BIER Report estimates that 1,000,000 man-rem will produce the following effects:

Effects of 1,000,000 Man-Rem	
Induced cancers[4]	100-450
Genetic defects[5]	30-750

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[3] ICRP Publication 14, Radiosensitivity and Spatial Distribution of Dose, Reports prepared by Two Task Forces of Committee 1 of the International Commission on Radiological Protection, Pergamon Press, Oxford, 1969, p. 20.

[4] NAS Bier Report, op. cit., p. 90.

[5] Ibid, p. 55.

These estimates apply to a population composed of young and old and male and female. Since only about one-half of the population would be within the reproductive age, the genetic effect estimate given above has been adjusted accordingly. There are several reasons why much more weight should be given to the higher estimates given above. In fact, recent data suggest that even the higher estimates may significantly underestimate the true effects.

2. Cancer Induction

The BEIR Report estimates that one million person-rem will induce 100 to 450 cancers.[6] The lower estimate is based upon the absolute risk model while the higher is based upon the relative risk model. Both are based upon the linear hypothesis. In the following sections, evidence is presented to demonstrate that even the upper estimate of the BEIR Report is too low, possibly by at least a factor of 10.

2.1 Absolute vs. Relative Risk Model

The BEIR Committee stated:

> No conclusion can be made at this time on the absolute versus relative risk model. 7/

The relative risk model is based upon radiobiological data which indicate that the rate of induction of various cancers per rem is proportional to the spontaneous incidence rate. At younger ages when the spontaneous cancer death per year is low, the rate

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Ibid, p. 90.

Ibid, p. 188.

of induction per year is also low, but at older ages when the spontaneous cancer death rate is 10 times higher, so is the rate of radiation-induced cancers. The absolute risk model tends to average these changing rates into a single value.

If the data base were complete, both models should give the same overall risk estimate. The absolute risk model would, however, obscure the varying radiosensitivity as a function of age. The problem is that the data base is not complete. The follow-up study on irradiated populations extends over a period of some 30 years -- much less than the lifetime of the younger members. The relative risk model represents a biologically reasonable basis for extrapolating the data base throughout the lifespan of the younger members of the study populations. The difference between the two models at this time is a result of this extrapolation for the radiation exposure experience in the early years of life.

Radiological data demonstrate that the young child (0-9 years) and the developing fetus are more sensitive to radiation than adults (>10 years). The higher risk estimate of the BIER Report assumes that the risk associated with radiation exposure of the young child extends throughout the lifespan. On the other hand, the BIER Report assumes that the risk associated with _in utero_ exposure extends only throughout the first 10 years of life. If the risk from _in utero_ exposure were assumed to extend throughout the lifespan, the risk estimate would be doubled and the risk of cancer would become 1,000 cancers per million person-rem.[8/]

[8/] _Ibid_, p. 188.

There is considerable biological evidence which demonstrates that injury (physiological damage) received during in utero development and in childhood is reflected in decreased physiological competence and increased mortality during adult life.[9] Thus there is a significant biological basis for assuming that the radiation injury incurred during in utero development and childhood will lead to an enhanced risk of cancer throughout the lifespan. Those who were exposed in utero and 0-9 years by the atom bombs in Japan are now just reaching theage where the important data on this question can be collected. The next few decades will reveal the pattern of excess cancer in adult life. Nevertheless, the present data on those irridiated in utero does conform with the biological expectation that this radiation injury will become manifest in adult life. Hiroo Kato has reported that there is an increased mortality of individuals exposed in utero by the atom bombs after they reached 10 years of age.

2.2 The Linear Hypothesis

The risk estimators in the BEIR Report are based upon the linear hypothesis. This hypothesis assumes that in the low dose range (that below where experimental data is available) the risk is directly proportional to the dose. The BEIR Committee, however, indicated that the linear hypothesis may either overestimate or underestimate the risk when applied in low dose/low dose rate situations.[10] Recent evidence indicates that the linear hypothesis may underestimate the effect of low dose/low rate irradiation. Much of this latest information has been summarized by Dr. Karl Z. Morgan, who concluded:

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[9] See, for example, Tamplin, A.R., et al., "A Criticism of the Stronglass Article on Fetal and Infant Mortality," Lawrence Livermore Laboratory, Livermore, California, UCID-15506, 22 July 1969; and Jones, H.B., "Factors in Longevity," Kaiser Foundation Medical Bulletin, Vol. 4, Nos. 9-10, September-October, 1956.

> Frequently in the literature it is stated that the linear hypothesis is a very conservative assumption. During the past years, however, many studies have indicated that this probably is not true in general and that at low doses and dose rates somatic damage per rad (and especially that from α-irradiation) probably is usually greater than would be assumed on the linear hypothesis. [11]

Dr. J. Martin Brown also reviewed the pertinent data on cancer induction and concluded:

> Contrary to popular belief there are quite good data on cancer induction in humans by low doses and/or low dose rates of low LET radiation. Risk estimates at these low doses were found not to be less than comparable risk estimates made from high doses. If anything, in fact, the data suggest the opposite. [12]

Dr. Irwin D. J. Bross has shown that there are some individuals in the population who are affected by radiation orders of magnitude greater than other individuals.[13] Thus, in interpreting the effects of radiation one must be cognizant of these highly susceptible individuals. Dr. John W. Baum has shown this population heterogeneity with respect to radiation sensitivity causes the linear hypothesis to underestimate the risk at low doses.[14] He concludes:

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[10] NAS BEIR Report, op. cit., p. 90.

[11] Morgan, Karl Z., Suggested Reduction of Permissible Exposure to Plutonium and Other Transuranium Elements, Journal of American Industrial Hygiene, August, 1975.

[12] Brown, J. Martin, Linearity vs. Non-Linearity of Dose Response for Radiation Carginogenesis, Health Physics 31, September, 1976, p. 231.

[13] Bross, Irwin D.J., Leukemia from Low-Level Radiation, New England J. of Med., Vol. 287, No. 3, 20 July 1972, pp. 107-110.

> It is concluded from this analyst that linear extrapolation from high doses to predict effects at low doses is not always conservative. This seems particularly so for radiation induced cancer in a heterogeneous population such as man. The need for much more experimental and epidemicological data at low doses and for low dose-rates is apparent. [15]

2.3 The Mancuso Report

On October 13, 1976, Drs. Thomas Mancuso, Alice Stewart and Mr. George Kneale presented a paper (hereinafter "Mancuso Report") at the Health Physics Society Symposium in Saratoga Springs, New York.[16] This report presents an analysis of a 29-year follow-up of the workers at the Hanford installation. It relates their cause of death to their occupational radiation exposure. It is, therefore, a study of the effects of low level radiation. The significant finding of this report is that for a total exposure of 2756 person-rem[17] there were 29 (27 to 31) radiogenic cancer cases.[18] It indicates that the linear hypothesis underestimates the risk for low dose/low dose rate irradiation by a significant factor.

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[14] Baum, J.W., Population Heterogeneity Hypothesis on Radiation Induced Cancer, Health Physics 25, August 1973, pp. 97-104.

[15] Ibid, p. 103.

[16] Mancuso Report, Mancuso, T.F., A. Stewart and G. Kneale, Radiation Exposure of Hanford Workers Dying From Various Causes, presented at the Tenth Midyear Symposium of the Health Physics Society, Saratoga Springs, New York, 13 October 1976, Revised Draft, March 1977.

[17] Ibid, Table 2.

A criticism of the Mancuso Report was presented at the same symposium by Marks and Gilbert.[19] It is significant to note that in their criticism Marks and Gilbert failed to mention an early report by Gilbert and Buschbom that came to conclusions similar to the Mancuso Report.[20] This report confirmed the findings of an earlier report by Dr. Samuel Milham, Jr., who concluded that the occupation exposure at Hanford resulted in a higher incidence of cancer. Gilbert and Buschbom concluded:

> We have established that there is a relationship between cancer as a cause of death and the total external dose received. [21]
>
> * * *
>
> For the time being radiation must be placed high on the list of suspects in considering possible explanations for the observed relationship. [22]

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[18] *Ibid*, p. 24.

[19] Marks, S., and E. Gilbert, comments on the paper by Mancuso, Stewart and Kneale presented at the Tenth Midyear Symposium of the Health Physics Society for presentation of the Mancuso Report.

[20] Gilbert, E.S., and R.L. Buschbom, An Evaluation of Milham's Analysis of Hanford Deaths, Draft, Battelle Northwest, July 1975.

[21] *Ibid*, p. 28.

[22] *Ibid*, p. 29.

In truth, the Mancuso Report only confirms these earlier studies. Gilbert had published a subsequent paper which was also not mentioned in the Marks and Gilbert criticism.[23/] In this paper, a different statistical approach still confirms the Milham (and hence Mancuso) findings. In this paper Gilbert concludes:

> Although the use of Milham cutpoints does suggest a slight dose-cancer relationship, it does not approach statistical significance and is not nearly as strong a relationship as found with the Milham data. [24/]

The analysis upon which these conclusions are based is summarized in Table A-1 of the report. This table is reproduced on the following page of this submission. Although no one of these 20 figures in this table attains statistical significance, a simple Spearman rank-correlation test (of the SMR and the % dying of cancer in the exposure groups) yields a correlation of 1.0 in all five groups which is significant at the 5% level.

One of the criticisms of the Mancuso Report was that it included all workers and not just longer term employees. The Gilbert paper considered, as a special group, only craftsmen and operators with 5 or more years at Hanford and found that the cancer excess was significant at the 0.01 level.[25/] The craftsmen and operators had the highest exposures.[26/]

Clearly, these studies of the Hanford workers show a relationship between low dose occupational exposure and cancer. They

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[23/] Gilbert, E.S., Proportional Mortality Analysis of Hanford Deaths, Draft Progress Report, Battelle Northwest, July 1976.

[24/] Ibid, p. 16.

[25/] Ibid, p. 5.

[26/] Ibid, pp. 2-3.

TABLE A-1

The Relationship of Cancer as a Cause of Death
and the Total Exposure Groups Used in the Milham Study

Dose in Rems	0.00-	1.00-	2.24-	6.60-	TOTAL
A) All Deaths					
SMR	1.05	1.03	1.10	1.29	
Number in Group	1835	318	165	94	2412
B) Ages 45-74, Year of Death 1950-1971					
Percent Dying from Cancer	21.1	21.4	23.5	28.6	21.8
Number in Group	939	234	119	77	1369
C) Milham Study Deaths Ages 45-74, Year of Death 1950-1973					
Percent Dying from Cancer	20.0	23.6	22.1	35.5	23.7
Number in Group	200	161	95	71	527
D) Milham Study Deaths Ages 45-74, Year of Death 1950-1971					
Percent Dying from Cancer	19.5	25.6	22.7	40.0	24.3
Number in Group	169	121	75	50	415
E) All Local Deaths Ages 45-74, Year of Death 1950-1971					
Percent Dying from Cancer	22.4	23.8	25.9	38.9	24.8
Number in Group	294	147	85	54	580

suggest a relationship that is 15 times larger than the upper estimate of the BIER Report (6500 cancers per million person rem rather than 450).

3. Genetic Effects

The latest biological evidence also indicates that the BIER Committee estimate of the genetic effects of radiation was too low. This should not come as a surprise because even the BIER Committee cautioned that its estimate of genetic effects may be too low:

> A major concern of the Subcommittee is the possible existence of a class of radiation-induced genetic damage that has been left out of the estimates. By relying so heavily on experimental data in the mouse we may have overlooked important effects that are not readily detected in mice, or the mouse may not be a proper laboratory model for the study of man. 27/

As if to reemphasize this, the Committee concluded this section by stating:

> We remind all who may use our estimates as a basis for policy decisions that these estimates are an attempt to take into account only known tangible effects of radiation, and that there may well be intangible effects in addition whose cumulative impact may be appreciable, although not novel. 28/

Present data indicate that its estimates were too low for two reasons. In the experiments of Dr. William L. Russell at the Oak Ridge National Laboratory, it was observed that the induced mutation

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27/ NAS BIER Report, op cit, p. 57.

28/ Ibid.

frequency at low dose rates was about 1/3 that observed at high dose rates. The factor of 1/3 was used by the BIER Committee. However, Dr. Mary F. Lyon, et al., have analyzed the Russell data along with additional data from experiments at low dose rates.[29] Their analysis shows that as the dose rate drops below some 0.01 r./min., the induced mutation frequency begins to increase. They conclude:

> In future estimates of the genetic hazards of environmental radiation, therefore, it would be prudent to increase this last figure to a value above that seen in mice at 0.01 r./min., for which the maximum likelihood estimate given by the data considered here is 10 X 10^{-8}. [30]

The value adopted in the BIER Report was 2.5 X 10^{-8} or a factor of 4 lower. This would lead to a factor of 4 underestimate in the genetic effects. These conclusions by Lyons, et al., are confirmed by the analysis of Abrahamson and Wolff, who also conclude that the value should be 4 times higher.[31]

Most, if not all, human disease has a genetic component. This includes such disease as heart disease, epilepsy, schizophrenia, asthma, diabetes and other degenerative diseases. These diseases are inherited in a complex fashion, i.e., they are the result of a single gene mutation. They are called multifactorial diseases.

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[29] Lyon, Mary F., D.G. Papworth and Rita J.S. Phillips, "Dose-rate and Mutation Frequency after Irradiation of Mouse Spermatogonia," Nature New Biology, Vol. 238, July 26, 1972, pp. 101-104.

[30] Ibid, p. 104.

[31] Abrahamson, S.E. and S. Wolff, "Reanalysis of Radiation-Induced Specific Locus Mutations in the Mouse," Nature, 264, p. 715, 1976.

Recent studies have shown that these diseases are twice as frequent as that estimated in the BIER Report.[32/] These diseases also represent the bulk of the genetically-determined diseases. When this is combined with the factor of 4 above, it indicates that the BIER Report underestimated the genetic effects by a factor of 8.

4. Radiation Protection Standards

The radiation protection standards in use throughout the world closely follow the recommendations of the International Commission on Radiological Protection (ICRP). These protection standards are not intended to represent safe levels. Rather, they are intended to be levels where the associated risk is acceptably low.

It is important to note that the history of these standards is that as new biological evidence has accumulated, the standards have been made more restrictive. For example, in 1934 the ICRP whole body occupational exposure standard was 0.2 rem/day. This would correspond to some 50/rem yr. The present standard is 10 times lower, 5 rem/yr. The latest biological evidence cited in the above section indicates that, in order to keep the risk acceptably low, this standard should be reduced by at least another factor of ten to 0.5 rem/yr.

4.1 Plutonium Body Burden Standard

Dr. Karl Z. Morgan has proposed that the present approach

32/ Trimble, B.K. and J.H. Doughty, "The Amount of Hereditary Disease in Human Populations," Ann. Human Genetics, 38, 1974.

used to calculate the Pu-239 bone dose underestimates the dose in rem by a factor of 60 to 240.[33] In effect, he suggests that the quality factor used is too low by this amount. The U.S. Nuclear Regulatory Commission Staff, accepting some and rejecting other of Morgan's arguments, acknowledges that present approach underestimates the bone dose by a factor of 10.[34]

As a consequence, the present maximum permissible body burden for plutonium is at least 10 times too high. An individual who has 0.5 the present permitted burden is actually being exposed to at least 5 times the appropriate burden. In other words, this risk associated with the present permissible burden is at least 10 times larger than was estimated when the present standard was established.

4.2 Worker Lawsuits

Because this latest data demonstrates that the biological effects of radiation are at least 10 times worse than previous estimates, the nuclear power industry has a number of lawsuits from employees who develop cancer. The first of these will occur in England in November. I anticipate that the data from the Hanford workers will cause the lawsuits to be decided in favor of the workers.

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[33] Morgan, Karl Z., Suggested Reduction of Permissible Exposure to Plutonium and Other Transuranium Elements, American Industrial Hygiene Journal, August 1975, pp. 567-575.

[34] U.S. Nuclear Regulatory Commission, hearing In the Matter of Generic Environmental Statement on Mixed Oxide Fuel (GESMO), Docket No. RM-50-5, Transcript, p. 3217, January 26, 1977.

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The British Journal of Radiology

Radiology now

Malignancies following low radiation exposures in man*

It is very hard to estimate the risk of malignancy entailed in exposure to low doses of ionizing radiation. The risk from higher doses (100 rad or more) can now be estimated approximately from several sources of epidemiological evidence, both for exposure of the whole body and for that of a number of organs or tissues. Many of these sources are imperfect in some respects, often involving inadequate periods of follow-up, deficient control data, uncertainty of dose at the site of interest or of RBE for exposures to radiation of high linear energy transfer (LET), or gross statistical imprecision if only small excess numbers of tumours are observed. Together, however, these data are beginning to justify estimates of the frequencies with which malignancies are induced in man in various tissues by moderately high absorbed doses, often delivered at high dose rate.

Until recently there was little information on the frequencies of tumour induction by doses of only a few rad, and no reliable basis for inferring this frequency from that observed at considerably higher doses. Moreover, the great variability in the frequency of tumour induction by radiation in different animal species, and even in different strains of the same species, prevents any quantitative inferences being applied directly to man.

Three pieces of evidence now appear to indicate the induction of malignancies in man by absorbed doses of less than 10 rad.

Leukaemia following atomic bomb exposures

Both in Hiroshima and in Nagasaki, the death rate from leukaemia for the period October 1950 to December 1972 exceeds that expected on the basis of Japanese national rates (Table 1), even for the group of people estimated to have been exposed to doses of less than 10 rad (tissue kerma in free air, according to the T65, or tentative 1965, dose estimate, Moriyama and Kato, 1973). For Hiroshima, about 20 per cent of the total dose is estimated to have been due to neutrons (Jablon and Kato, 1971), so that it is difficult to evaluate the equivalent total dose of low LET radiation, particularly at these low doses where RBE may be high. The increase in death rate, however, although small, is also significant in Nagasaki where no significant neutron exposure occurred, and where the mean gamma dose was again small, with an average of 4 rad in 60 per cent of the group and less than 1 rad in the remainder. The mean absorbed doses in bone marrow are under review (Jones *et al.*, 1975) but are unlikely to have been higher than these kerma estimates.

The use of Japanese national rates as a basis for comparison could be questioned if there were regional differences in leukaemia incidence, but it may be noted (Table 1) that no increase in mortality ratio

TABLE 1

MORTALITY RATIOS FOR LEUKAEMIA RELATIVE TO JAPANESE NATIONAL STATISTICS
(Moriyama and Kato, 1973)

<table>
<tr><td colspan="3">Males and females, all ages, deaths 1950–1972
(with confidence limits, at 10 and 90 percentile points)</td></tr>
<tr><td>Group</td><td>Exposed at 0–9 rad</td><td>Not in city</td></tr>
<tr><td>Hiroshima</td><td>1·48
(1·18–1·84)</td><td>0·88
(0·54–1·35)</td></tr>
<tr><td>Nagasaki</td><td>1·78
(1·11–2·63)</td><td>1·11
(0·48–2·21)</td></tr>
<tr><td colspan="3">Kerma estimates (in free air) for 0–9 rad groups
(Jablon and Kato, 1971)</td></tr>
<tr><td>Hiroshima</td><td colspan="2">29,934 persons at less than 1 rad
13,787 at mean dose 2·9 rad (gamma) 0·8 rad (neutron)</td></tr>
<tr><td>Nagasaki</td><td colspan="2">4,699 persons at less than 1 rad
6,705 at mean dose 4·0 rad (gamma) 0·0 rad (neutron)</td></tr>
</table>

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*Reprints: Sir E. E. Pochin, National Radiological Protection Board, Harwell, Didcot, Oxfordshire OX11 0RQ.

is observed in those residents who were not in the city at the time of bombing, returning to it shortly after.

Thyroid cancers following scalp irradiation in childhood

Modan *et al.* (1974) report the development of a significantly greater number of cancers of the head and neck in children whose scalps had been irradiated for tinea capitis, than in two matched control groups. Twelve thyroid tumours diagnosed as being malignant occurred within 12 to 24 years of irradiation of 10,902 children. Two such tumours were recorded in 10,902 non-irradiated subjects matched for age, sex, country of origin and date of immigration. One was recorded in a second control group of 5,496 unirradiated siblings of the irradiated children, matched for age to within five years. The staff who searched records for tumour incidence were unaware of whether named subjects were from irradiated or control groups.

The scalp was irradiated on separate days by five fields at an air dose of 350 to 400 R. Detailed studies on a phantom (Werner *et al.*, 1968) showed that the thyroid should have received a total average absorbed dose of 6·2 to 7·4 rad. On this basis, the rate of tumour induction per rad is given by

$$\frac{(12-2)}{10{,}902\cdot 6{\cdot}5}=(140\pm 50)\,10^{-6}\text{ cases per rad.}$$

It will be noted that this is consistent with the rates per rad observed by Hempelmann (1968) in children following estimated mean doses to the thyroid of about 350 rad. Modan and his colleagues emphasize that the thyroid exposures may have been greater than those estimated in the phantom if a constant head position was not maintained during the therapy. It seems unlikely, however, that mean thyroid doses would have greatly exceeded those estimated, and probable therefore that thyroid malignancies may be induced occasionally in children at doses of less than 10 rad.

Malignancies following fetal irradiation

The earliest indication that low doses might induce malignancies came from evidence that mothers of children with leukaemia had more frequently had diagnostic X-ray examinations of the pelvis during the relevant pregnancy than mothers of normal children (Stewart *et al.*, 1956). It was later found that the frequency with which malignancies developed within the first ten years of life was increased, probably by about 40 per cent in children exposed to diagnostic X rays while *in utero* (McMahon, 1962), the increase affecting focal tumours, particularly of the central nervous system, as well as leukaemia. No accurate estimate could be obtained of the risk of tumour induction per rad, since no direct information was available of the absorbed dose in the fetus per film or per examination. From a study of a number of estimates of fetal dose in the period 1946 to 1957 in British publications, the incidences reported by Stewart and Kneale (1970) were considered by UNSCEAR (1972) to correspond to fetal absorbed doses varying in individual cases from 0·2 to 20 rad, with a mean of less than 2 rad, and to a risk of fatal malignancy of about $23\cdot 10^{-6}$ per rad per year to age 10.

The inference that the radiation caused malignancies was, however, questioned at first. For example, a sub-group of mothers might have been more frequently X-rayed than mothers in the control group because of hereditary abnormalities, *e.g.* of the pelvis, and this sub-group might have a preponderance of children who developed malignant disease as a result of some associated congenital abnormality.

Such a source of bias now appears to be excluded, however, by two considerations. Firstly, Stewart and Kneale (1970) showed that the likelihood of subsequent malignancy per examination increased about linearly with the number of films used in the examination, where this number was known. And secondly, Mole (1974) has shown from analysis of the data published by Stewart that mothers have pelvic X-ray examinations much more frequently (in 55 per cent of cases) during twin pregnancies than during singleton pregnancies (when only 10 per cent of mothers are X-rayed). Despite this, the excess frequency of malignancies in twins who were irradiated *in utero* is no higher than that in singletons so irradiated. Therefore the factors which called for a greater frequency of pelvic X rays, at least in this type of pregnancy, do not appear to be associated with an increase in childhood malignancies. For leukaemia, the excess rate per intra-uterine examination was $(118\pm 16)10^{-6}$ in singletons and $(143\pm 46)10^{-6}$ in twins. For focal cancers the result was similar, the excess rates per examination being $(124\pm 17)10^{-6}$ in singletons and $(114\pm 53)10^{-6}$ in twins.

It now appears likely, therefore, that absorbed doses of only a few rads in the fetus may induce malignancies of various types, and that the risk per rad of induction of such tumours does not differ greatly from that inferred for whole body exposures of adults at considerably higher absorbed doses (UNSCEAR, 1972).

Discussion

These indications of the induction of malignancies in man at doses of less than 10 rad do not in themselves give any adequate basis for the various estimates required for protection purposes, of the risks of occupational exposures at corresponding dose levels of the whole body, or of various organs in the adult. Still less do they justify inferences as to the effects of exposure of populations at mean annual doses of only a few millirad in excess of background from various environmental sources.

They do, however, add weight to the indication of tumour induction from fractionated exposures, for example from repeated fluoroscopies, in which the total doses are high but individual fractions are low, and so to the possibility of obtaining estimates of low dose effect from them.

They also suggest that no very large "protraction factor" may be needed in reducing dose estimates per rad derived from high doses to infer those applicable at low doses. This conclusion already appeared likely for genetic effects and for changes induced in cell cultures (both for low LET radiation and even more so for high LET), where primary effects of radiation appear to involve changes induced in single cells (Kellerer and Rossi, 1971). For cancer induction, however, where microdosimetric considerations suggest the initial involvement of groups of cells (Rossi and Kellerer, 1972) the expectation is less clear. Direct evidence that occasional malignancies may in certain circumstances be induced in man at absorbed doses of only a few rad, however, indicate the need for continued caution in determining protection criteria in this respect also.

E. E. Pochin

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Book review

A Handbook of Radiography. By J. A. Ross and R. W. Galloway, 4th edition, pp. 275 + index, 1976 (H. K. Lewis & Co.), £7·00.

This is a neat little hardback pocket-book intended for D.S.R. radiography students and student radiologists.

The fourth edition has been brought up to date with the addition of simple descriptions of new techniques such as ultrasonics and electron radiography, but to try to explain computerized axial scanning in half a page seems to be over ambitious.

As an attempt to cover the whole of the D.S.R. syllabus in one small volume the book fails. However, Chapter 2 on radiation hazards and the short descriptions of specialized techniques could be useful for reference.

Chapters 4–7 on radiographic positioning contain some excellent line-drawings, but in an attempt at brevity sometimes omit accurate centering points or special extra views which are the very things which student radiographers are most likely to need to look up.

As a short manual of practical radiography the reviewer feels that this book could be useful to radiologists studying for Part I of the F.R.C.R. and possibly as a revision for student radiographers.

Jennifer Richmond.

[illegible]

J. Rotblat

[illegible]

Risk Factor for Radiation-Induced Leukaemia among Entrants to Hiroshima

A large number (over 40,000) of persons entered Hiroshima after the bombing for rescue work or in search of relatives. These entrants were exposed to the γ-rays from radioactivity induced in the soil and buildings by the neutrons emitted at fission, and to a lesser extent to fall-out radiation. Hirose (1968) and Watanabe (1974) reported a significant increase in leukaemia incidence among the early entrants, here defined as those who entered the city during the first three days. This paper is an attempt to estimate the leukaemia risk factor in this population.

A. Estimate of average dose

Although no attempt appears to have been made to determine the doses received by individual entrants, it is possible to make a fairly close estimate of the average dose received by them. For this purpose the following assumptions are made:

(a) all early entrants entered Hiroshima 6 hours after the explosion;

(b) they all remained in the city for at least 4 days (which in practice means an infinite period);

(c) they all stayed in an area within a radius of 1000 metres from the hypocentre;

(d) within that area they were uniformly distributed;

(e) the risk of leukaemia is linearly related to the dose.

Assumption (a) follows from the information that a fire raged in the city during the first 6 hours, making it impossible for anyone to enter within a 1000 metres.

Assumptions (b) and (c) are most unlikely. An estimate made on these will therefore give an upper limit to the dose, or a lower limit to the risk factor.

Assumption (d) seems plausible.

Assumption (e) is justified even for low LET radiation at low doses, because the quadratic term is then small by comparison (Brown, 1977).

The average dose is calculated from $\bar{D} = \sum f_r D_r$, where f_r is the fraction of the total early-entrant population, who were in a ring at a distance r from the hypocentre ($\sum f_r = 1$), and D_r is the cumulative dose at that distance.

The values of f_γ follow from assumption (d). The values of D_f for neutron-induced radioactivity, relative to the value at the hypocentre, are obtained from fig. 6 of the paper by Hashizume et al. (1969). From this the average cumulative dose is found to be 13% of that at the hypocentre.

From the same paper (fig. 10) it is found that the cumulative dose from 6 hours to infinity was 67% of that from one hour after the explosion to infinity. The value of the latter was studied by several authors, and Takeshita (1975) gives as the average value of these studies 101 rad (kerma in air).

Thus, the average dose from neutron-induced radiation is 101 x 0.67 x 0.13 = 8.9 rad.

The dose due to fall-out is also taken from Takeshita. Assuming that the dose was the same over the whole area, the cumulative dose from 6 hours to infinity is 1.5 rad. The total dose is thus 10.4 rad.

To convert kerma into absorbed dose, the factor 0.65, which is applicable to bone marrow, is used. This gives a value for the average absorbed dose of 68 mGy.

An estimate of the error to be attached to this figure can be obtained from the distribution of values given by different authors (Table 2 of Takeshita). The standard error of the mean is about 30%.

B. Calculation of the leukaemia risk factor

According to Hirose (1968) over the period 1950-68, there were 45 cases of leukaemia among the 25798 persons who entered Hiroshima during the first 3 days, and 9 cases among the 18328 persons who entered during the following 12 days.

The assumption is now made that the latter group received zero dose (thus again underestimating the risk factor) and can be used as the control group for the early entrants.

In a population of 25798 one would thus expect to find 12.7 cases of spontaneous leukaemia. The excess of 32.3 then leads to a risk factor of 18 x 10^{-3}Sv^{-1}.

The statistical error of the leukaemia incidence is 25%, making the total error 40%.

No information is available about the age and sex distribution of the entrants but it is unlikely that children or old people would be used for rescue work. The majority of the entrants were thus probably of an age group least sensitive to radiation. The sex difference for leukaemogenesis appears to be insignificant.

C. Comparison with ICRP

ICRP 26 recommends a risk factor for leukaemia of 2 x 10^{-3} Sv^{-1}. The figure obtained for the early entrants is thus 9 ± 4 times higher. In view of the assumptions made, the actual value is likely to be nearer the upper end of the range than the lower.

The risk factor used by ICRP is based on observations from two groups of populations: (a) medical X-rays (mainly therapeutic); (b) the A-bomb survivors in Hiroshima and Nagasaki.

In the first group only partial body exposure occurred and this may carry a lower risk than that based on the assumption that the risk is proportional to the fraction of bone marrow exposed.

With regard to the A-bomb survivors, it is known that the incidence rate per rad of cancers of the thyroid, breast and lung is lower among them than in other irradiated populations by factors ranging from 4 to 7 (UNSCEAR, 1977). The present estimate for leukaemia incidence is thus in line with these observations.

D. Conclusions

Unless it can be shown that the reported figure for leukaemia among the early entrants is wrong by a large factor, the following conclusions are inescapable:

1. Whatever the reason for the lower incidence of cancer among the survivors of the explosions and the absence of other radiation effects (Rotblat, 1977), it is clear that the results obtained from the A-bomb survivors cannot be used to establish risk factors for "normal" exposure.
2. The risk factors recommended by ICRP are too low, probably by an order of magnitude for leukaemia, and by a somewhat smaller factor for other cancers.

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IN THE HIGH COURT OF JUSTICE

QUEEN'S BENCH DIVISION

GLADYS TROUGHTON (Widow and Administratrix
of the Estate of Jonathan Troughton
deceased)

Plaintiff

and

BRITISH NUCLEAR FUELS LIMITED

Defendants

....

1974-K-No. 89

JOAN KING (Widow and Administratrix
of the Estate of Henry Edward King
deceased)

Plaintiff

and

BRITISH NUCLEAR FUELS LIMITED

Defendants

....

These two actions are the first to come to trial in which it is alleged that plutonium workers have suffered injury as the result of exposure to radiation. It is therefore in the interests of the workers at Windscale, their families and the public at large that the basis upon which these two actions have been settled should be publicly known.

Under the Nuclear Installations Act 1965 if a Plaintiff establishes on the balance of probabilities that an injury and subsequent death were caused by radiation, the source of which came from the Defendants premises, the Defendants are absolutely liable to pay comepnsation.

On 10th January 1975 Mr. Jonathan Troughton died at the age of 55 of myeloma, an exceedingly rare type of cancer.

From 1954 to 1963 Mr. Troughton worked as a plutonium worker. In 1963 it was discovered that the content within his body of plutonium exceeded the limits laid down by the International Commission for Radiological Protection. So Mr. Troughton was removed from plutonium work. In 1972 he became unwell and myeloma was diagnosed.

The conclusion of the very eminent doctors and scientists who have considered Mr. Troughton's case is that on the balance of probabilities, in view of special factors in his case, his myeloma was induced by radiation at work. The factors include the dosages of irradiation received by Mr. Troughton and the amount of plutonium within his body, the latter of which,unusually,exceeded the prescribed international limit, and some evidence of a causal relationship between myeloma and radiation.

In recognition of the very particular facts of Mr. Troughton's case the Defendants have agreed that by consent, there should be judgment for the Plaintiff in the sum of £22,441.00 with costs.

The sum of £22,441.00 represents the full value of Mrs. Troughton's claim.

Settlement of Mrs. King's action requires your Lordship's approval because she has a dependent daughter Amanda Joan who was 16 on the 1st September 1977

From 1952 to July 1971 Mr. King worked at Windscale.

In July 1971 he had to retire due to partial blindness.

From 1952 until 1961 Mr. King worked as a plutonium worker. In 1961 it was suspected that the plutonium content within his body was somewhat high and so he was removed from plutonium work. On the 12th May 1973 Mr. King died of a brain tumour.

There is a substantial difference of opinion among the experts as to whether or not on the balance of probabilities Mr. King's brain tumour was radiation induced. Unlike Mr. Troughton's case Mr. King's exposure to radiation and body content of plutonium were well within the limits laid down by the International Commission for Radiological Protection. Further, the evidence of a causal connection between radiation and brain tumours is scant and controversial.

The Defendants while denying liability have agreed to pay the sum of £8,000.00 with costs.

The sum of £8,000.00 represents about one third of the full value of the claim.

I have advised in view of what I consider to be a substantial risk of Mrs. King's action failing that it would be unwise to reject this settlement. Mrs. King has accepted my advice.

Therefore I ask for approval of this settlement.

These two actions have been settled on the particular facts and issues arising in them, and they should not be regarded as a precedent for any future claim, pending claim or action. So far as the trade union which has supported these two actions and the Defendants are concerned, any such claim will be treated individually and strictly on its evidential merits.

In this connection it is right that the public should know that the risk of a particular individual or plutonium worker getting a radiation induced cancer is statistically very small.

Finally I would like to thank the distinguished specialists, Dame Janet Vaughan, Dr. Alice Stewart, Mr. W.M. Ross, Dr. A. Tamplin and Dr. W.J. Meredith for their unstinted help in the preparation of these cases.

In turn on their behalf I would like to thank Dr. G.B. Schofield, the Defendants' senior medical officer at Windscale, for his help and co-operation.

Statement read by Mr. M. Harland Q.C.

15.11.77

Mr. ROGERS. Our last witness today will be Dr. Martin Sperling.

Dr. Sperling, we will be pleased to receive your statement at this time.

STATEMENT OF MARTIN SPERLING, PH. D.

Dr. SPERLING. Chairman Rogers, Mr. Carter, and members of the committee, my involvement in the matters under consideration today is with nuclear test Smoky and related troop exercises at Camp Desert Rock during late summer 1957 and has consisted of efforts to determine probable radiation exposure levels experienced by participants.

By radiation exposure I mean whole body doses as estimated from initial radiation calculations and fallout data, independently of film badge readings, and doses to the bone marrow due to inhalation of fission fragments and fragment daughters, induced radioactivity and plutonium oxide.

These determinations all depend critically on the distances of troops from ground zero, both during observation of the initial explosion and later during troop movements. They also depend on the time and duration of these movements. Much of this information is contained in the official press releases of the Nevada test organization, in particular releases OTI-57-75—August 9, 1957—OTI-57-87—August 22, 1957—OTI-57-93—August 24, 1957—and OTI-57-102 with OTI-57-102/ Add 2—August 31, 1957 [see p. 58]. Some additional information regarding the times and durations of helicopter operations was provided by Dr. Glyn Caldwell of the Center for Disease Control from HumRRO documents in his possession. Finally, certain times and distances applicable to operations of the 82d Airborne Division have been estimated by Mr. Paul Cooper, a Smoky participant, in interviews, with the press and with me personally. In the following, I will point out areas of controversy as they apply.

Initial radiation; that is, neutrons and gamma rays produced during the fission process, can be estimated from standard models that have been constructed by weapon effects physicists, given the known tower height and explosive energy. The direction from ground zero has no bearing on this calculation. External whole body doses are then graphed as a function of distance, as in figure 1 [see p. 55], which follows my statement. Four distances can be singled out for particular attention: (1) 3,000 yards, or 1.7 miles, the observation distance of the 82d Airborne Division estimated by Paul Cooper; (2) 4,500 yards, or 2.6 miles, the originally planned observation distance of the 82d Airborne Division; (3) 8,500 yards, or 4.8 miles, the alternate observation distance of the 12th Infantry Battle Group; (4) 14,000 yards, or 8 miles, the alternate observation distance of the 82d Airborne Division. Alternate observation points were necessitated by last-minute wind changes, and the distances given above were specified in OTI-57-102.

At the three larger distances, the neutron and gamma ray doses were below 0.1 rem. When I say below, I mean in most cases quite far below. But at 3,000 yards they were 0.25 and 4.3 rem, respectively. This assumes that protective trenches were not used. Mr. Cooper asserted they were not used. I have also spoken with Mr. Donald Coe and Mr. Carl Hartstern, who were with the 12th Infantry Battle Group, and the experiences of both confirm Mr. Cooper's statement.

In comparison with the simplicity of initial radiation calculations, the estimation of exposures associated with fallout is relatively complex, involving ambient weather conditions, physiologic factors, and specific physical details of the troop operations. To reduce the inhalation problem to proportions manageable without using a large computer, I combined experimental data on the abundance of 20 to 25 fission fragments with the inhalation model contained in the U.S. Nuclear Regulatory Commission Reactor Safety Study, WASH-1400, also known as the Rasmussen report, NUREG-75/014; that is, I treated the problem as a reactor accident, but substituted an isotopic input appropriate for nuclear weapons. The resulting calculation encompasses three major stages: (1) radioactive debris is deposited on the desert floor; (2) debris is resuspended into the air by mechanical or aerodynamic motions; (3) it is breathed, deposited in the upper and lower respiratory system, then cleared or retained with calculable probabilities. Item 3 was studied in detail by the International Commission on Radiological Protection Task Group on Lung Dynamics, and incorporated by NRC into WASH-1400.

Two dozen or so fragment varieties do not fully account for the more than 200 known fallout constituents, which also include materials induced by neutron activation. To compensate for this discrepancy, the initial fragment inventory was also used to compute an external dose, which was then divided into the external dose estimable from fallout data, the resulting quotient being exactly the correction factor needed to convert the computed external dose due to fallout from the partial inventory, to the measured fallout from the complete inventory. This same correction was then applied to the results of the inhalation dose computation.

I studied the case of Mr. Donald Coe in detail at the request of Congressman Carter. According to the press releases, Task Force Warrior, the group Mr. Coe was with, observed the 5:30 a.m.—sunrise—detonation from positions 8,500 yards southwest of ground zero, a last-minute change due to wind conditions from the originally planned positions 8,500 yards southeast. The correctness of the decision to reorient the observation point is confirmed by the detailed fallout map. At 7:30 a.m. or shortly thereafter, troops were transported "swiftly, close to ground level, to the objective area some 4,500 yards from ground zero." Mr. Coe recalls flying in a tandem rotorcraft, which would be the Vertol H-21. The exercise continued with an assault on an enemy mountain position, possibly Quartzite Mountain, until it was terminated at 9:45 a.m.

Based upon the above information, Mr. Coe's external whole body dose was 0.3 rem, in excellent agreement with his second film badge report covering the Smoky interval, showing 0.2 rem. This dose was received almost entirely in the objective area, assumed to have been a constant 4,500 yards from ground zero. Mr. Coe's inhalation exposure to his bone marrow was comparable, 0.3 rem, cumulative over the following 10 years. To arrive at this result, a resuspension factor must be assumed. The resuspension factor is defined as the ratio of radioactive material concentrated in the air to that deposited on the ground. This was assumed to have the value 0.001 per meter, representative of vigorous mechanical disturbances under dry conditions.

However, at the time of the disembarkation from the helicopters, high prevailing local winds due to the twin rotors, coupled with dry desert conditions, could have resulted in essentially all the deposited radioactive material being resuspended into the air for a brief time, this effect being similar to that of directing an electric fan over a tabletop covered with fine powder from a height comparable to the blade width. In such circumstances, the resuspension could be expected to rise to extremely large values and to remain large until the resulting dust cloud settled again to the ground. At a distance of 20 years, it is impossible to determine the precise effects of low helicopter altitudes in transit, multiple helicopters concentrated in the objective area, ambient wind conditions, and the spatial relationship of Mr. Coe to the aircraft, but assuming an average resuspended cloud height of 10 feet for a period of 10 minutes, Mr. Coe inhaled an additional bone marrow dose of about 13.2 rem.

I have also studied in detail the account of Mr. Paul Cooper. Mr. Cooper states that he and fellow members of the 82d Airborne Division walked from a distance of 3,000 yards to within 100 yards of ground zero, arriving at about 1 hour after detonation, and remaining in the vicinity for a period of 30 minutes to 1 hour. Press release OTI-57-93 describes a starting point of 4,500 yards and a series of four maneuvers taking the 82d Airborne a total distance of 1,500 yards toward ground zero. However, press release OTI-57-102, which announces a change in the observation point to a place 8 miles distant, describes no maneuvers toward the detonation center. Based on Mr. Cooper's description, the inhaled dose could have been extremely high, in the vicinity of 100 rem, without any aerodynamic disturbances but strictly as a result of troop movements.

During my initial investigations, I suspected the predominant influence on inhalation exposures of a few dominant long-lived emitters. This appears not to have been the case. The computed exposures are consistent with influences from a large number of radionuclides, each making a small but significant contribution, with primary exposures occurring over periods of hours or days, but not years. If some troops were exposed to very high levels of radiation, even this degree of temporal distribution might have tended to raise the threshold for visible signs of radiation sickness.

Plutonium is a special case. I have been unable to determine with certainty whether Smoky used plutonium, or if it did, in what proportion to uranium-235. With plutonium present, but with the biological effectiveness assumed in WASH-1400, there would be no change in the computational results, nor would there be if this effectiveness were increased by a factor of 1,000. Whether a small number of macroscopic plutonium particles could induce leukemia is a controversial question on which I do not attempt to pass judgment.

I would like now to address the difference between the initial observation points specified by Mr. Cooper and press release OTI-57-102. In an interview with People magazine, at a time prior to his knowledge of my work, Mr. Cooper stated:

> Just before they detonated the bomb, they told us to turn around and put our hands over our eyes. When it went off we felt almost unbearable heat, like backing up to a fire with tight Levi's on. We could see the bones in our hands through our closed eyelids, as if we were taking a big X-ray. Then they told us to turn around and watch the bomb. We saw the fireball go off, and the shock waves knocked several of us off our feet. The others hung on to each other to stay up. It was like being in winds of 80 mph, and the ground was shaking like it was an earthquake.

In fact, prior to the appearance of this interview and without knowledge of its existence, I had calculated the peak wind velocity as a function of observation distance, with the result as shown in figure 2 [see p. 56]. At a distance of 3,000 yards, 1.7 miles, the predicted peak wind velocities of 83 miles per hour, in excellent agreement with Mr. Cooper's statement. In contrast, the predicted peak wind velocity at a distance of 8 miles was 7 miles per hour.

In regard to heat, figure 3 [see p. 57] shows the absorbed heat and the effect on bare skin as a function of distance. At a distance of 1.7 miles, the radiant exposure was in excess of 10 calories per square centimeter, sufficient to cause third-degree burns on bare skin. However, with helmets on, turned-up collars, facing away from the fireball with hands covering both eyes, no bare skin is exposed. The heat would have been intense, but of short duration.

I can find no significance to the account of seeing bones through closed eyelids, other than that the light was very intense. However, no focusing effect would be expected.

Smoky was not the only source of radiation exposure for troops involved in these exercises. There were eight test detonations during the period from July 22 to September 4, 1957, when Mr. Coe was at Camp Desert Rock, including: Kepler, Owens, Stokes, Shasta, Doppler, Franklin Prime, Smoky, and Galileo. Separate film badge records were kept for the period July 26, 1957 to August 27, 1957, and August 27, 1957 to September 2, 1957, the latter period covering Smoky and Galileo Exposures are indicated during both periods. However, I have confined my calculations to Smoky, the largest, but more importantly, the only one for which I have an official or credible unofficial account of troop positions and movements.

As to the effect of these exposures, the report of the National Academy of Sciences, National Research Council Advisory Committee on the Biological Effects of Ionizing Radiations—BEIR report—states:

> In atomic bomb survivors of Hiroshima and Nagasaki, and in British patients treated with intensive spinal irradiation for ankylosing spondylitis, an increased incidence of all forms of leukemia except the chronic lymphocytic type has been observed. The relationship between the excess in incidence and the radiation dose, as observed at relatively high doses and high dose rates, is consistent with a linear dose-incidence function * * *. The slope of the fitted straight line corresponds to a risk of about 1 case of leukemia per 1 million exposed persons, per year, per rem. The excess in incidence, which was evident within 3 to 4 years after irradiation, declined within 15 years but still persists at a diminished level in atomic bomb survivors, now 25 years after exposure * * *."

Concerning the validity of extrapolating observations made at high doses and dose rates to more moderate exposures, the so-called linear hypothesis, the report further states:

> "At this time, then, the linear hypothesis, which allows the mean tissue dose to be used as the appropriate measure of radiation exposure, provides the only workable approach to numerical estimation of the risk in a population. Further, since there is

no means at present of determining the value of the dose-effect slope in the low-dose region of interest, use of the linear extrapolation from data obtained at high doses and dose rates may be justified on pragmatic grounds as a basis for risk estimation."

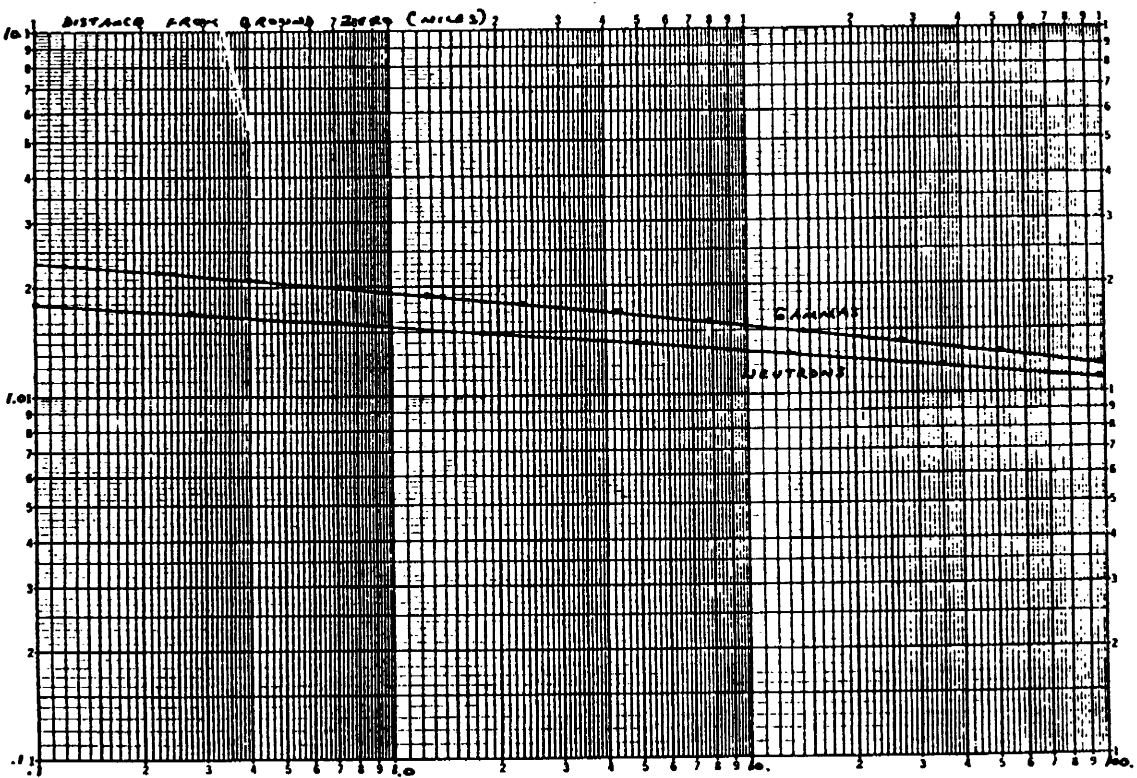
Based on the findings contained in the BEIR report, a doubling of the incidence rate for leukemia in the relevant age group would be expected for each 30 rem of exposure. At this point, my interpretation of the wording of the report differs from that of Dr. Tamplin. I get a doubling dose closer to the value he suggests on the basis of more recent studies, but still too conservative by a factor of 3.

The BEIR report also anticipates 1.5 cases of induced cancer of other types for each induced instance of leukemia.

In conclusion, I would like to mention several limitations of these investigations. They were undertaken initially out of curiosity and later pursued as a result of my impression that I might be the only source of general dosimetric calculations outside of agencies that had been or had evolved from the initial sponsors of the nuclear tests and troop exercises in question. The physical situation was very complex, available documentation—at least documentation that has been available to me—is minimal, and 20 years separates us from the events. The research was done in a limited amount of my personal time, without sponsorship by my company or any Federal agency, and with simplified models, without the benefit of a scientific computer.

[Testimony resumes on p. 65.]

[Attachments to Dr. Sperling's statement follow:]



DISTANCE FROM GROUND ZERO (MILES)
10
1.0
.1
1.0
10.
100.
GAMMAS
NEUTRONS
ROENTGENS (GAMMAS)

FIGURE 1

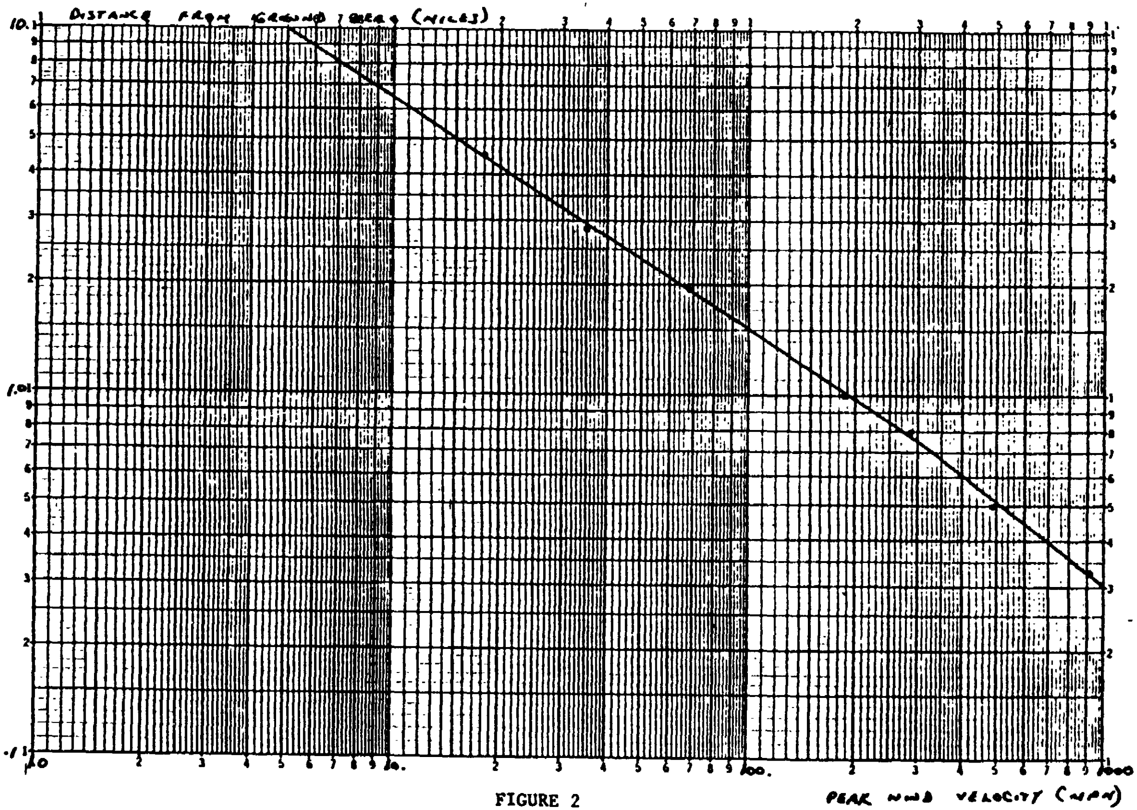

DISTANCE FROM GROUND ZERO (MILES)
10.
1.0
.1
10
10.
100.
1000
PEAK WIND VELOCITY (MPH)

FIGURE 2

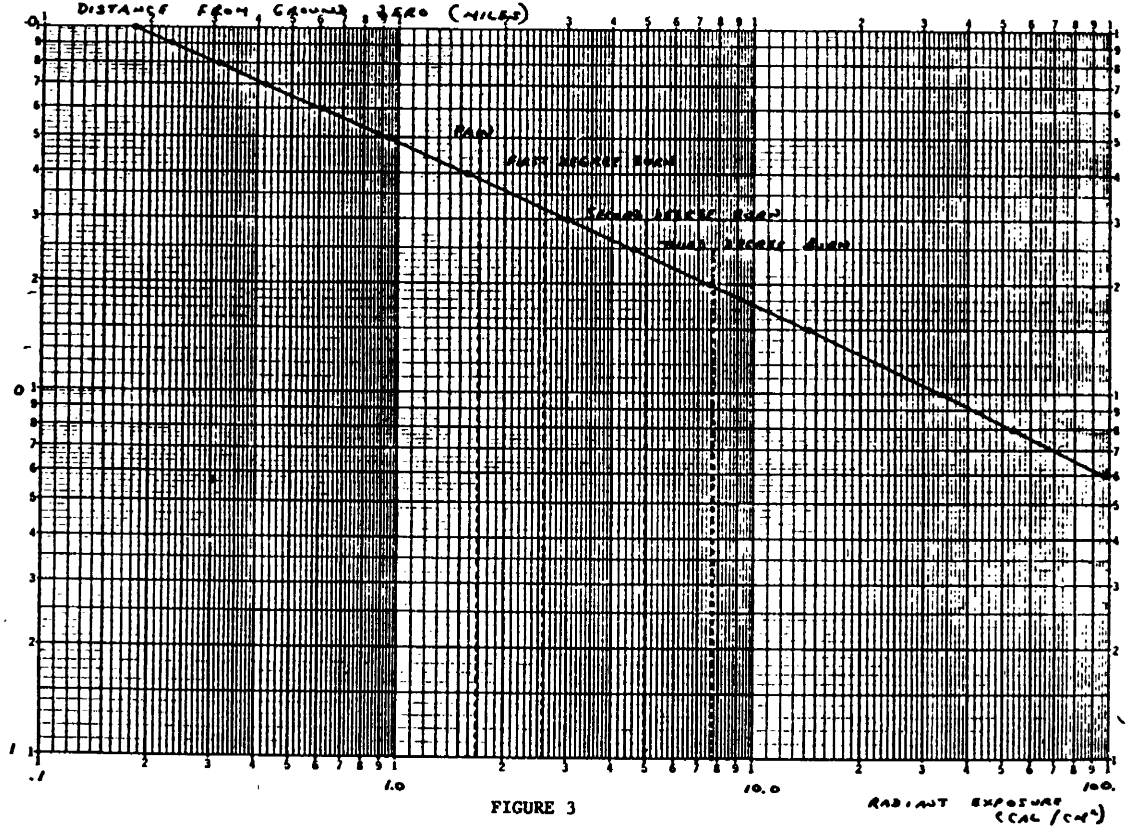

DISTANCE FROM GROUND ZERO (MILES)
.01
0
1
PAIN
FIRST DEGREE BURN
SECOND DEGREE BURN
THIRD DEGREE BURN
.1
1.0
10.0
100.
RADIANT EXPOSURE (CAL/CM²)

FIGURE 3

OTI-57-75

Nevada Test Organization
OFFICE OF TEST INFORMATION
1235 South Main Street
Las Vegas, Nevada

Telephone: DUdley 2-6350

August 9, 1957

FOR IMMEDIATE RELEASE

Memorandum for Press, Radio and TV:

As indicated in the enclosed release, the Army Pentomic Troop Test is to be held in conjunction with the August 19 shot at the Nevada Test Site. The shot is scheduled to be detonated from a tower, with an above nominal yield.

You may recall from previous detonations that dust and distance usually preclude a clear view from News Nob of the troop maneuver following the shot.

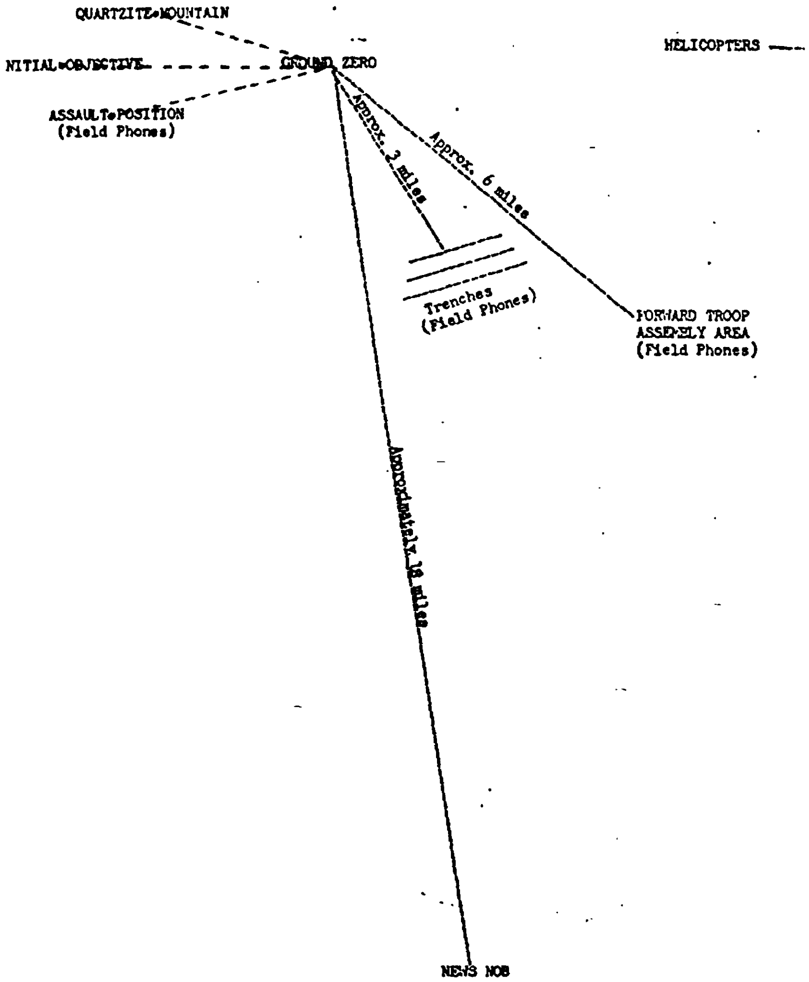
With this in view, arrangements have been made for media representatives to observe the shot and maneuver from three points: (1) forward observer trenches, where a small group of Engineer and Infantry security troops will be located; (2) forward troop assembly area, from which position the Pentomic unit of the 1st Battle Group, 12th Infantry, Fourth Infantry Division, Fort Lewis, Washington, will move to the assault position by helicopter; and (3) News Nob.

Military telephone lines will be available to News Nob from the trenches, forward assembly area, and assault position. (See sketch) Helicopter lift from trench and assembly areas, to assault area and return to News Nob is contemplated, as well as a visit to the Army Equipment Display area after the blast.

A helicopter will be available shortly after the detonation to move film and tape from News Nob to the Camp Desert Rock air strip in the event news media chartered aircraft are used.

Major Bill Koons, Army Representative in this office, will appreciate an early indication from news media representatives on the kind of coverage desired.

The date, time, and place of the pre-shot press briefing will be announced later.


QUARTZITE MOUNTAIN
NITIAL OBJECTIVE
GROUND ZERO
HELICOPTERS
ASSAULT POSITION
(Field Phones)
Approx. 2 miles
Approx. 6 miles
Trenches
(Field Phones)
FORWARD TROOP
ASSEMBLY AREA
(Field Phones)
Approximately 18 miles
NEWS NOB

OTI-57-87

Nevada Test Organization
OFFICE OF TEST INFORMATION
1235 South Main Street
Las Vegas, Nevada

August 22, 1957

Telephone: DUdley 2-6350

FOR IMMEDIATE RELEASE

CAMP DESERT ROCK, NEV.---Giant transport helicopters, modern day version of the Army mule, will play a feature role in nuclear warfare exercises scheduled for next week at nearby Yucca Flat in the Nevada Test Site.

The helicopters will deliver specially-trained shock troops behind the lines of a mythical enemy moments after detonation of a nuclear device named "Smoky."

Participating in this Infantry troop test set for August 28 will be 600 soldiers of the First Battle Group, 12th Infantry, supported by a crack unit of Canadians from the Queen's Own Rifles Regiment from Alberta.

Often referred to as a "truck with eggbeater attached," the helicopter has been given a key assignment in the Army's new "Pentomic" battle concept which demands great speed and a high degree of maneuverability of fighting units.

Here in the desert where torrid winds kick up dust clouds and daytime temperatures languish at over 100 degrees, the helicopter will face its most severe and challenging test. Even in Korea, where the "choppers" made a name for themselves in the Army, conditions were more favorable than they are in this hot and mountainous wasteland.

But the helicopter, now an integral part of U.S. Army aviation, has been ordained to perform the toughest of all atomic war missions: To deliver the infantryman to the front line and beyond, take him arms and food to continue battle, and bring him out of the combat area when tired or wounded.

Helicopters are part of the Army's own air force. The daring, unsung pilots wear distinctive silver wings, but their uniforms are the same as that worn by the infantryman with whom they work and train every day.

In town on a weekend, much of a 'copter pilot's time is spent explaining to those he meets the difference between the Air Force and "Army Aviation." His branch, taken over five years ago by the Transportation Corps, is not even fully understood by the World War II veteran.

To the Army commander, however, the helicopter and its pilot are fully understood and appreciated, for they make possible the swift movement and supply of hard-hitting battle units fighting with—and against—nuclear weapons.

(more)

Here at Desert Rock to prove the helicopter can exploit an atomic attack are officers and men of the 85th Army Aviation Battalion, commanded by Lt. Col. Charles Ernest of Carmel, Calif. A veteran pilot, Col. Ernest pioneered early developments that have given the Army its own flying arm.

The battalion is composed of two helicopter companies--the 31st from Ft. Benning, Ga., flying the H-34's (Sikorsky), and the 8th from Ft. Bragg, North Carolina, which flies the H-21 (Vertol Corporation's "flying banana"). Major A. V. Juliano of Smithville, Texas, a former artillery officer, commands the 31st. Major John F. Sullivan, World War II Air Force officer from Janesville, Wisc., heads up the 8th.

The "34" has one rotor and a lift capacity of 4,000 pounds. It will haul 12 fully-equipped combat troops and is equipped to carry ammunition, drums of gasoline, or a jeep into the combat zone.

The "21" has tandom rotors and seating capacity for 21 troops. Both ships can travel at speeds in excess of 100 miles an hour, fly in any direction, hover over an objective and land on a mountain peak or in a river bed.

The men who fly these helicopters are warrant officer pilots. All have undergone nearly a year of extensive flight training to master their versatile but sensitive craft. The pilots, carefully screened, come from all branches of the Army.

When Smoky, a device of above-nominal yield, is detonated from its 700-foot tower, the helicopters will be ready, and after the blast, will move forward to the attack position to pick up the waiting troops.

Troops will be flown swiftly, close to ground level, to the objective area some 4,500 yards from "ground zero." The helicopters will continue to be active in this atomic maneuver as they return for equipment and supplies for the troops.

Col. Ernest, his pilots and maintenance specialists, await H-Hour at Yucca Flat and the opportunity to demonstrate that the Army mule has found a worthy successor.

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OTI-57-93

Nevada Test Organization
OFFICE OF TEST INFORMATION
1235 South Main Street
Las Vegas, Nevada

August 24, 1957

Telephone: DUdley 2-6350

FOR IMMEDIATE RELEASE

CAMP DESERT ROCK, NEV.--Can a highly trained soldier think clearly and perform the duties of his fighting mission efficiently in the shadow of a nuclear bomb's mushroom cloud?

Two minutes after a blast with an explosive force of over 20,000 tons TNT, will his hands tremble as he kneels to field-strip and reassemble his rifle?

Will he obey promptly the orders of his commanding officer, or will he falter as a choking dust cloud whirls around him?

Will he move quickly to clear a mine field, or will he "gawk" at the eerie "snow cap" forming above his head?

For the first time since man learned to split the atom, the United States Army is prepared to find the answers to these and other unknowns concerning human behavior in nuclear warfare, in connection with shot "Smoky" which will be detonated above Yucca Flat at the Nevada Test Site Wednesday, August 28.

To carry out this pioneer mission, the Army has called upon a provisional company from its proud and famous 82nd Airborne Division, from Fort Bragg, North Carolina. The company is composed of 163 enlisted men and seven officers, all carefully hand-picked from units of the entire 82nd.

Commanding Officer of the test company is Captain William Stovall, World War II and Korean war veteran from Lexington, Kentucky.

Supervising the tests under conditions that can scarcely be more realistic, will be a team of 15 scientists from the Human Resources Research Office (HumRRO) George Washington University. They are psychologists, physiologists, statisticians, and sociologists who will accompany the troops into the blast area of Yucca Flat 50 miles north of this desert post.

While the evaluation is going on, a major military tactical maneuver employing a 700 - man "Pentomic" battle group will be staged to test new fighting concepts.

Head of the HumRRO team is Shepard G. Schwartz, sociologist from Alexandria, Va. Since July 24, he has been working with officers of the Airborne unit setting up a series of tests.

(more)

The Army believes the results will be a helpful guide to its commanders whose war strategy is now geared to nuclear weapons. This is why the Army selected its best men--physically and mentally--for one of the most important assignments ever given a group of peacetime soldiers,

Since they arrived here last month, the test company has been going through daily "dry runs" to insure best possible performance when "H-Hour" arrives. The test will begin with the troops occupying trenches 4500 yards from ground zero.

Two minutes after Smoky is detonated, the men will be ordered out of the trenches and forward in the direction of the blast. For one hour, they will work in the area of the blast. They will be ordered to:

1. Field strip or take apart their rifles and reassemble them for inspection. (In dry run this takes about 50 second);

2. Advance another 200 yards into a mine field where they will form small units to clear four lanes through the area;

3. Re-form in "skirmishers" (battle formation) and advance 1200 yards toward ground zero;

4. Move through infiltration courses where they will crawl 50 yards under barbed wire, take battle cover, and finally rush toward individual targets throwing hand grenades into fox holes.

At this point, the test will have been completed and the men will assemble in marching formation to hike out of the area.

Using a carefully devised rating system, the HumRRO team will score the soldiers on everything from finger dexterity to the degree of distraction from shock, dust and noise.

The men have been thoroughly briefed on the capabilities of nuclear weapons. They are not worried about rumors and speculation concerning blasts and radiation. A dry run performance test on "D-2" will be compared with individual ratings given during and after the actual firing of Smoky.

Testing for individual proficiency in combat skills has long been a subject of HumRRO study. Many of the realistic training methods used in World War II and Korea were the direct result of HumRRO findings and recommendations. The research group is a non-governmental agency supported by a continuing contract with Department of Army. They function under the Army's Research and Development department, headed by Lt. Gen. James M. Gavin.

What will the Army do if it finds that troops lose effectiveness under the mushroom cloud, or if they are too bemused, curious or stunned to respond to battle orders?

HumRRO, which recommended the replacement of the ancient bulls-eye with life-size snap-up targets early in World War II, will probably be asked to devise new training methods to prepare today's soldier for his new atom warfare job.

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OTI-57-102

Nevada Test Organization
OFFICE OF TEST INFORMATION
1235 South Main Street
Las Vegas, Nevada

August 31, 1957

Telephone: DUdley 2-6350

FOR IMMEDIATE RELEASE

Smoky, an experimental device by Livermore Laboratory, was fired from a 700-foot tower in Yucca Flat at 5:30 a.m. today. It was the fifteenth full-scale nuclear test in the summer 1957 series.

At about 4:45 a.m. the shot time was postponed from the scheduled 5 a.m. until 5:30 a.m. to provide time for balloon runs and aircraft checks to determine wind speeds and directions above the Test Site.

On the basis of early data, the Test Director reported that the yield was in the designed range, or in a range of about twice nominal.

The explosion was visually of interest to observers because of the continuing intensity and visibility of the blue light caused by ionization of nitrogen surrounding the fireball. This resulted from the darkness existing at shot time.

The cloud rose above 35,000 feet, penetrating slightly through the tropopause. It was the opinion of observers that there was less dust blasted up from the desert and a less stocky and dirty-appearing cloud stem than has accompanied lower yield shots fired from 500-foot towers. Cloud-tracking aircraft reported at 6:30 a.m. that the cloud top was being blown generally toward the east at about 48 knots, with lower segments moving more slowly in a more southeasterly direction. There was considerable variance in wind direction, providing desired shear which should result in fairly wide diffusion of the cloud segments, reducing the intensity of fallout at any one point.

The blast was quite strong in the observer areas and was measured at slightly under 16 millibars at the Control Point, where it was felt as a sharp blow and heard as a sharp report, followed by rumbling and echoes from the hills. Bishop and Inyokern reported hearing rumbles and bangs, and St. George and Tonopah reported rumbles.

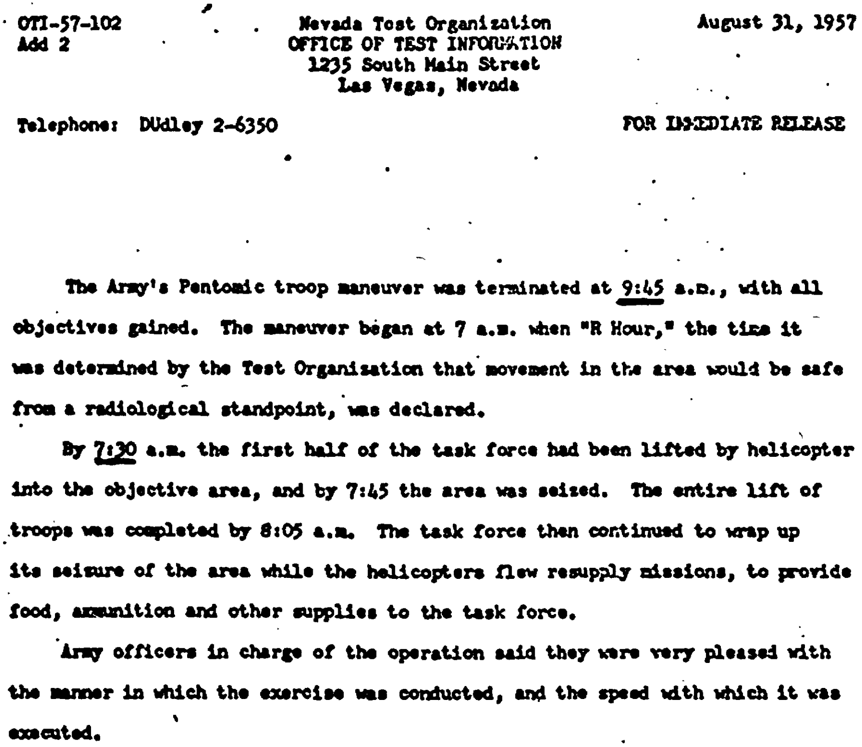
There were about 30 experiments on the sequence timer. Thirty-two U.S. Air Force and nine Navy aircraft participated with effects, training, and technical support flights. Five light Army aircraft and 40 helicopters were used in a post-shot exercise.

As part of the civil effects program, prototypes of mass shelters were subjected to effects experiments for the French and German Governments.

Pre-shot predictions that there probably would be fairly heavy fallout immediately south and southeast of the zero point caused changes in the Desert Rock Army maneuver. The trenches at 4,500 yards were not used by military observers or troops of the "human research" project, the former observing from a point some eight miles distant and the latter simply observing from a point near News Nob. The "human research" project may be conducted on the next shot.

Troops scheduled to participate in the post-shot assault maneuver observed from an alternate area 8,500 yards southwest of zero point, instead of southeast.

Fire chiefs from Los Angeles, Bakersfield and San Diego, California, and Las Vegas were scheduled to test methods for decontaminating structures and areas at about three hours after the shot.



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Nevada Test Organization
OFFICE OF TEST INFORMATION
1235 South Main Street
Las Vegas, Nevada

August 31, 1957

Telephone: DUdley 2-6350

FOR IMMEDIATE RELEASE

The Army's Pentomic troop maneuver was terminated at 9:45 a.m., with all objectives gained. The maneuver began at 7 a.m. when "R Hour," the time it was determined by the Test Organization that movement in the area would be safe from a radiological standpoint, was declared.

By 7:30 a.m. the first half of the task force had been lifted by helicopter into the objective area, and by 7:45 the area was seized. The entire lift of troops was completed by 8:05 a.m. The task force then continued to wrap up its seizure of the area while the helicopters flew resupply missions, to provide food, ammunition and other supplies to the task force.

Army officers in charge of the operation said they were very pleased with the manner in which the exercise was conducted, and the speed with which it was executed.

Mr. ROGERS. Thank you very much, Dr. Sperling. I think we will have questions.

Dr. Morgan, how long did you work for the Atomic Energy Commission?

Dr. MORGAN. I worked at Oak Ridge National Laboratory for 29 years. They were under contract with the Atomic Energy Commission.

Mr. ROGERS. And in what capacity there?

Dr. MORGAN. I was Director of the Health Physics Division.

Mr. ROGERS. Does radiation have a cumulative effect? Can you get a dose and have no effect or is it a cumulative effect?

Dr. MORGAN. As I indicated in my paper, Mr. Rogers, at the beginning of this period at Oak Ridge there were many who thought that exposure to low levels of radiation was completely reparable and that you could come back weeks later and there would be no cumulative effect. But I believe that the majority of scientists today believe that there is some component of each exposure that resides indefinitely there. So there is a cumulative component.

Mr. ROGERS. So even at low level exposures it is cumulative?

Dr. MORGAN. Even at very low levels the bad effects of radiation, including that from natural background radiation, add up and contribute to the likelihood that a person will die of cancer at some later date.

Mr. ROGERS. Dr. Carter.

Mr. CARTER. Thank you, Mr. Chairman.

I want to compliment all of you gentleman on your presentations here today. I think they have been very good and very enlightening and informative to us.

Dr. Morgan, is there any doubt in your mind but that ionizing radition does cause cancer?

Dr. MORGAN. No. There is certainly no doubt whatever in my mind. I think that all scientists perhaps would agree that ionizing radiation can cause cancer. The only question is how much exposure to low-level radiation will double the cancer incidence or will be a significant increase in cancer.

Mr. CARTER. Do we know of a level of radiation at which cancer is caused, or is there a level below which cancer is not caused?

Dr. MORGAN. Apparently all radiation contributes to the chance that one will die of a malignancy. The first year of my professional life was in the field of cosmic radiation. We know or at least some of us believe that even that adds to the chance of dying of cancer. Perhaps it is a small contributor but we believe it makes its imprint.

Mr. CARTER. We know that we are constantly exposed to cosmic radiation, that is true, and to radiation from the ground on which we walk, if there is uranium underneath or things of that nature. Is that correct?

Dr. MORGAN. That is correct.

Mr. CARTER. All of this radiation, then, is hazardous to our health. In fact there are certain places in the world that have a higher incidence of cancer perhaps because of radiation in the Earth, is that correct?

Dr. MORGAN. I think we have to assume that that is true.

Mr. CARTER. In France, India, and Brazil?

Dr. MORGAN. This is what we expect and I think there is some data that would confirm that.

Mr. CARTER. Did you happen to be at Smoky during this explosion on August 31, 1957?

Dr. MORGAN No. In August 1957 I had a team working for me at the test site. I got reports back from this team who were studying the effects of the blast on the Japanese-type houses that were located in the area. It was one of the responsibilities of my group to determine the dose received by the survivors of Hiroshima and Nagasaki. So I did have a team there, but I did not cover that particular test.

Mr. CARTER. If it had been left up to you, would you have had such a test from a tower or did you at that time realize the dangers inherent in such an explosion?

Dr. MORGAN. Although our realization of the risks of radiation have changed through the years, even that early, in 1957, I was frightened and appalled when I first heard these troops were in trenches and would go to point zero shortly after the blast.

In discussions I had with the person in charge of my program there, he indicated that this event led to more residual contamination than any of the other tests we covered, so much so that as they drove in at high speed to collect their instruments they turned around and retreated when they got within 3 or 4 miles of point zero.

Mr. CARTER. I have here a photograph taken of Smoky, above which is a caption stating, "The dust cloud hovered over the desert as the task force marched toward its rendezvous with helicopters." There is the dust. The dust contained primarily we think alpha radiation, is that correct?

Dr. MORGAN. There was no question that there was a great deal of fallout material from the weapon. This would have included in addition to the alpha, of course, the beta, gamma fission products and the reduced activity. During the early period most of the dose was due to the beta gamma radiation.

Mr. CARTER. Beta and gamma registered on the film; is that correct?

Dr. Morgan That is correct. This truck which carried my men into the site, they were reading the gamma dose when they turned around.

Mr. CARTER. Did the film badge register the true amount of the radiation to which they were exposed?

Dr. MORGAN. The film badges when used and interpreted properly are a very valuable device to estimate part of the risk. But since, as you point out, sir, the risk can consist of various types of radiation, the film badges give no indication whatsoever of the inhalation hazard of the alpha emitting radio nucleants. If they had gone in very early, they would give a very poor indication of the neutron dose. For the beta they give a very poor indication.

So the badges use were limited almost entirely to the gamma component.

Mr. CARTER. They did not register the alpha radiation?

Dr. MORGAN. That is correct. They registered none of that.

Mr. CARTER. Alpha emitting particles were inhaled into the lungs and perhaps stayed there for quite a while; is that true?

Dr. MORGAN. Yes.

Mr. CARTER. Or else went into the bone?

Dr. MORGAN. During the years I was at Oak Ridge my special interest in research was internal hazards from radioactive materials, particularly the apha emitters and something like plutonium with a half life of 20,000 years. It would continue to radiate the lung, skeleton and liver for a long time.

In our calculations, the data available would indicate that in the skeleton the half life is about 200 years. It takes about 200 years for the skeleton to reduce the amount there that is present. So it is essentially fixed at a constant level.

Mr. CARTER. The half life of the ingested alpha emitting particles could be 200 years?

Dr. MORGAN. The half life biologically is 200 and for plutonium 239 it is 24,000 years. Since the biological elimination rate is faster than the radiation delay rate it would be primarily the 200-year life that would determine how long it is in the skeleton. For practical purposes, once you have a deposition in the bone or the liver or the lung, those are the three critical tissues in this case, it would irradiate the human body for the rest of the person's life.

Mr. CARTER. And there would be a continuous cause of leukemia within the body itself, ingested in the form of alpha particles; is that correct?

Dr. MORGAN. The data that is available on animals for inhalation and ingestion of plutonium and plutonium-like elements, actinides, could suggest that bone sarcoma and carcinoma are more likely to occur than leukemia but leukemia is certainly a possibility.

Mr. CARTER. I believe one of the statements made today indicated that the likelihood of other forms of cancer was 1.5 to 1 to leukemia.

Dr. MORGAN. It is in that order.

Mr. CARTER. Skin cancer is perhaps the most common other form of cancer associated with radiation exposure, isn't it? Didn't you make the statement that other forms of cancer occurred as a result of radiation in the ratio of 1.5 to 1 in regard to leukemia?

Dr. SPERLING. I made that statement. It was from the BEIR report.

Mr. CARTER. Doctor, is there any doubt in your mind that this atomic blast at Smoky, a blast of 44 kilotons, three times the yield as at Hiroshima could have caused leukemia in the men who were observing that blast? And, actually, the Smoky yield was 48 kilotons, instead of 44 kilotons, which has not been revealed by some of our officials, I understand.

Dr. MORGAN. No, there is no doubt whatever. The man who was in charge of my tests, he and his driver turned around and fled in the opposite direction back to the control point because they didn't want to take this risk.

Mr. CARTER. Do you believe, Doctor, that this is the reason we discontinued atomic blasts in the atmosphere and went underground?

Dr. TAMPLIN. Yes. Back prior to 1957, of course, there was a great deal of controversy raging in this country over the effects of the fallout radiation. By 1958 it led to the voluntary atmospheric halt. Then it subsequently carried on into 1962 and the atmospheric test ban treaty was actually signed. The concern was with the fallout and its effects on the general population.

I was at the Lawrence Radiation Laboratory in 1963 when I did some calculations. I estimated what the dosages were to children's thyroids as a result of the fallout from the weapons tests at the Nevada test site. For example, in some of the cities that were close to the test site in southwest Utah such as St. George, Utah, the sort of average estimate of what the dose was to the children's thyroids was about 120 rad. In an area which included most of Utah, most of Colorado and part of New Mexico the dose to the children's thyroids was averaged over that area, some 50 rad. So there was a large—you know the general public received substantial amounts of radiation. Some of those people living in southwest Utah and some of the other towns in Nevada that got fallout over the period of time that those tests were going on probably achieved a doubling dose.

So far as these troops going in, you know one of the problems I had in kind of reconstructing what was going on in Nevada was that there was just no very good data. The troops that they had in the early phases, they had Army troops they would bring in and give them Geiger counters and have them wander around. I think it would be almost impossible to reconstruct what the troops got as a result of those exercises.

From what I know of the atomic bomb explosions, if these troops are standing in 80-mile an hour winds, they must have been exposed to a very substantial dose just from the base surge.

Mr. CARTER. Is there any doubt in your mind, then, that the Smoky blast and the other blasts associated with the 1957 test series caused, or could have caused leukemia and other forms of cancer among the troops?

Dr. TAMPLIN. My feeling was that it certainly did cause some cancer among those troops and also among the population residing outside of the test site, the general public.

Mr. Carter Thank you, Doctor.

Dr. Sperling, I would like to ask you if you think that the measurement on Mr. Coe's film badge was indicative of the full amount of exposure to radiation. I believe his badge read 0.3 rem.

Dr. SPERLING. His film badge reading for the second period was about 0.2 rem. That seems to agree with the external whole body dose quite well. The film badge was never intended to measure inhalation.

Mr. CARTER. But when he was brought in to near ground zero and ingested radiation particles, what would you have estimated his total exposure to have been at that time, including the 0.3 rem which showed on his badge?

Dr. SPERLING. His exposure came from three sources: X-rays, beta rays, and alpha particles. The total depends on the idea of helicopter enhanced resuspension and how long it lasted. For a 10-minute resuspension his total dose was about 13.5 rem.

Mr. CARTER. Would you think that this dose was sufficient in some cases, such as in individuals with histories of allergies and asthma, to cause leukemia?

Dr. SPERLING. I am not an authority on the relationship between stresses and the incidence of leukemia, but for the general population, from the data that was examined by the BEIR committee, it that would be sufficient to increase his probability of getting leukemia by about 44 percent.

If the figures Dr. Tamplin suggests are correct, it would be sufficient to more than double the chance of causing leukemia.

Mr. CARTER. There is one other question I would like to ask Dr. Morgan, if I might, and that is that there were some 3,000 troops exposed at Smoky, and I understand that approximately 432 of those persons have been located. What would you consider to be a number of cases of leukemia that would be statistically significant in demonstrating causation of leukemia, what number would be sufficient?

Dr. SPERLING. I am a little prejudiced on this because I have talked with Dr. Caldwell at the Center for Disease Control.

Mr. CARTER. I thank you, but I was referring this to Dr. Morgan.

Dr. SPERLING. I am sorry.

Dr. MORGAN. I would prefer Dr. Sperling would take this question because he has looked at the numbers and has a better idea of the dose records that are available.

Mr. CARTER. Whatever you would like, Doctor.

Dr. MORGAN. As long as I am before the mike I will say that it was my understanding that only one or a few per platoon wore badges so we don't have good distribution of numbers of badges so we can get a good indication of the probable error. At that time the low values that were reported, in view of our own personal experience with the tests, that is of my men, some of us felt there might have been a reversal on some of the films so that the reading on the film might have been meaningless.

Mr. CARTER. The normal incidence of leukemia, I believe, in men in the 40 to 44 age group of all races is about 4.1 per 100,000. In this case, out of 432, the incidence I will say, is much, much higher.

Thank you, Mr. Chairman.

Mr. ROGERS. Thank you.

Let me ask you this: Would you say based on this testimony and your study that our current standards for human exposure to low level radiation are sufficient? Dr. Morgan?

Dr. MORGAN. Since I believe that there is no safe level of exposure, to me it is a matter of choosing some indixes, some starting point and using that in determining our safe working procedures.

I am pleased that the present Nuclear Regulatory Commission and the International Commission for Radiological Protection and the National Council and so on, their principal guide is not what is a safe level, but their guide is that you should keep exposures as low as reasonably achievable. So if you can avoid all exposure, I think you should.

But, no, specifically, to your question, 5 rem per year occupational, I think as long as in most large laboratories they operate as they have in the past, that that might be acceptable because only 1 or 2 percent, maybe at most 5 percent, would ever be reached. As long as practices can be carried out that way I think the present level is good. But when you look at some of our industries, the nuclear power industry where some of them are getting close to half the 5 rems per year, some of the employees the full 5 rems per year, I think when those practices persist, then we have only one choice, to lower the maximum permissible exposure level.

I think as far as internal dose as Mr. Carter was referring to for alphas and so on, I think we need to take a very careful look at some of those maximum permissible body burdens and permissible values. I think we need to lower those values for certain isotopes in view of more recent information.

Mr. ROGERS. So you are saying they do need to be changed?

Dr. MORGAN. Correct. I think some of the levels need to be changed, but you can change them any way you like. Unless you have proper enforcement and proper motivation and understanding of the risks, you still don't accomplish what you are after.

Mr. ROGERS. Dr. Sperling, do you have any comment? Would you say you are in basic agreement? Do you think they definitely need changing or definitely not?

Dr. SPERLING. As Doctor Morgan mentioned 5 rem per year, I was thinking about myself working in an occupation in which I received significant exposures. I was thinking that I would like my occupational exposure level to be no more than 2 equivalent of my yearly environmental dose. This is very consistent with the regulatory changes Dr. Morgan recommends.

Mr. ROGERS. Dr. Tamplin?

Dr. TAMPLIN. I strongly believe that the standards are too high and that they should be lowered. As a matter of fact, the Natural

Resources Defense Council petitioned the Nuclear Regulatory Commission to reduce the occupational exposure standards by tenfold. After having done that the Environmental Protection Agency for some reason asked us if we would petition them also. So we petitioned the Environmental Protection Agency.

Our petition is still pending before the Nuclear Regulatory Commission, but the Environmental Protection Agency, who asked for the petition, turned it down some months ago. But subsequent to the Mancuso report coming out, we asked them to reconsider it. So they reopened the petition before the EPA.

Mr. ROGERS. So it has now been reopened?

Mr. OTTINGER. Can you identify who the "we" there is?

Dr. TAMPLIN. Dr. Rowe is head of the branch of the EPA who asked us to petition.

Mr. ROGERS. Thank you.

Mr. Ottinger?

Mr. OTTINGER. I would like each of you to describe any efforts by any agency of the government, the AEC, ERDA, Department of Energy, the Department of Defense, to interfere, first, with your own efforts to disclose to the public your concerns over the adverse health effects of ionizing radiation and then any efforts that you have been aware of interference with other scientists making this information available. In the case of Dr. Sperling, any problems you had with any government people with respect to testifying before this committee today.

I guess we can start with Dr. Morgan in the same order that you testified or however you would like to proceed.

And lastly, whether to your knowledge this kind of effort is still going on within the Government either to suppress or minimize this kind of information about the adverse health effects of ionizing radiation.

Dr. TAMPLIN. Since everything is sitting in front of me I will start off.

Back in 1969 when my colleague, John Goffman, and I became critical of the radiation exposure standards, we had been critical of them internal within the Atomic Energy Commission up until 1969, but in 1969, because we had been listened to with deference for so long, we decided to go public and we presented our findings in a scientific meeting in San Francisco.

I literally will say it, after that all hell broke out. I had a group at that time at the laboratory of 13 people. Within a short period of time the group was cut down to two people and then the other person was fired. Also, there was an effort on the part of the laboratory to censor a report that I was going to present to the American Association for the Advancement of Science meeting. I did subsequently alter the report somewhat so that the laboratory would agree to type it and to pay my way to that. That was sort of the last time that the laboratory paid me any travel even though I went to such things as the American Cancer Society meetings to present the scientific material on the biological effects of radiation.

But when I went to those I had to arrange my own travel and I had to take vacation pay. As a matter of fact, when I was speaking before the American Cancer Society science writers seminar they docked me vacation pay for Saturday and Sunday. They were getting a little carried away, I thought, at that point.

Because the press had got so interested in the whole controversy, the laboratory was clearly embarrassed about proceeding to the ultimate thing and that was firing Goffman and I. Goffman had a research program on chromosomes and cancer which was about a $250,000 a year program. That was cut off. Goffman left the laboratory. But I stayed on at Lawrence Radiation Laboratory as essentially a nonperson. I had no assignments, but I had an office and I could get my paycheck every month, but I was never given any assignment in the laboratory. I stayed on because I thought it was a necessary irritant and embarrassment to the Atomic Energy Commission.

Now when Congress in its wisdom passed the Energy Reorganization Act and it started off with a statement, "The Atomic Energy Commission is hereby abolished," there was rejoicing in the streets among my friends. Because of that I decided I would leave the laboratory in 1974. I felt that I should not stay on as an embarrassment to the new people at ERDA.

But as I followed what has gone on at ERDA, particularly relative to the Mancuso, Steward, and Kneale report, I see it is just the same old thing which is still going on. To some extent I am not too surprised because this has been nothing but a game of bureaucratic musical chairs. Even though Congress reorganizes and forms new departments, the same old guys are still running the store.

Mr. ROGERS. Would the gentleman yield?

Mr. OTTINGER. Yes, of course.

Mr. ROGERS. I think it would be well for you to place in the record the names of those people who you had dealings with that you are referring to.

Dr. TAMPLIN. I would simply mention, say, the head of ERDA's environmental department, Dr. Liverman, who had previously been head of the Division of Biology and Medicine of the Atomic Energy Commission.

Mr. ROGERS. Thank you.

Mr. OTTINGER. Why don't each of you comment and some of us may want to ask some followup question about your experience in this area.

Dr. Morgan?

Dr. MORGAN. It is very difficult to determine with certainty how much of this suppression or suppression of the press and actions against freedom of speech go on because in a laboratory, a manager of an operation doesn't accuse you of what he has in mind. He will pick out some little minor detail of a paper, why you shouldn't present that paper, why it is not appropriate or timely. So I am convinced that much more of this goes on.

Furthermore, there are not many people that wish to make an issue so they will lose their job and would no longer have support for their family and no chance of getting another job in their profession.

So I think what information surfaces is perhaps a very small amount of what actually goes on.

My own experience, I didn't run into any serious problem until shortly before the time I was to retire from Oak Ridge National

Laboratory. At the time this happened to be in July 1971. I had sent ahead to Nuremberg, Germany, 200 copies of a paper I was to deliver there. I was on vacation in Switzerland for a week. When I went to the airport in Zurich the girl at the desk said excitedly that there have been numerous phone calls for you, get to a phone as quickly as you can. She gave me the number, a number in the States.

Dr. Peller, the assistant associate director of Oak Ridge National Laboratory came to the phone. He said since I had left Oak Ridge National Laboratory they had looked at my paper again and found that some changes had to be made in it. He had instructed persons in the laboratory to delete certain parts of my paper and he had wired the authorities in Nuremberg to throw the 200 copies of my paper away and to replace it by this paper which had certain sections and pages torn out of it. The paper in short showed that some types of reactors were safer than others. It showed that the thermal breeder system that we were interested in at the laboratory at the time was, according to my calculations, some 270 times safer than the liquid metal fast breeder system which shortly afterward became the only egg in our basket.

When certain persons came into the Atomic Energy Commission other programs were stopped in favor of this particular system. I am pleased that our President has seen wise to cancel that program, to cancel the Clinch River Breeder system.

I could talk for hours on why I believe it not only is unsafe but it is uneconomical and it won't breed the way we would like it to breed.

So my paper was untimely. I should have waited until President Carter was elected to prepare this paper and perhaps it would have been better received.

The reason given for making the changes in my paper were that certain little technical things I had not given sufficient attention to. I won't go into those here, but when I returned to the laboratory I was told by numbers of people there who had a part in changing my paper that it would be unthinkable that my paper would be presented at the time because a decision had been made to spend millions of dollars on this new program and were this paper to be given it might mean the firing of hundreds of people at the laboratory.

My feeling was that the freedom of the press was more important than a few hundred jobs for our democracy.

Mr. OTTINGER. Were there any other instances where others were involved or you are aware of?

Dr. MORGAN. I am aware of numerous other instances in areas where research was not supported because it is unpopular. Linus Pauling has never gotten support of his program at a decent level even though I feel he has made some remarkable findings in his studies in California.

Mr. OTTINGER. Could you supply some of those details to the committee? Perhaps it is too much of an imposition to ask you to recite them now. If we could have some of the details of some of those other incidents.

Mr. ROGERS. Could you supply them for the record?

Dr. MORGAN. I could do that, yes.

[Testimony resumes on p. 120.]

[The following information was received for the record:]

Censured or Repressed Scientific Information

In regard to cases of censured or repressed scientific information I mention the following:

1. My own paper (copy enclosed of original and revised version, that I gave at Neuherberg, Germany.

2. My early publication (Tolerance Concentrations of Radioactive Substances, J. Physical and Colloid Chem. 51, 584, 1947).

3. Findings of Dr. Samuel Milham, Jr. showing an increase in cancer risk. This paper was seriously delayed in publication.

4. Several cases reported in Environment 17, No. 5, July August 1975.

5. Experiences of Mr. W. B. Cottrell in 1969-71 at ORNL in reference to the loss of coolant accident in a LWR.

6. Experiences of Dr. John Dabbs of ORNL in reference to publications considered adverse for the LMFBR program.

7. Deletion of Chapter 7, "Exposure Limits of Biological Effects," from the publication of Doses Due to Accidentally Released Plutonium from an LMFBR, ORNL-NSIC-74, B. R. Fish, G. W. Keilholtz, W. S. Snyder and S. D. Swisher (November 1972).

8. Experiences of Drs. D. Geesaman, John Goffman and A. Tamplin.

9. A number of cases reviewed in Science, 169, 743 August 21, 1970.

10. Case of Mr. Ronald Fluegge who resigned from NRC because of irregularities, Nuclear Information, AIF, No. 23, January 1977.

11. Findings of Monroe W. Wexler at ORNL, "Steel-Structure Failures, Nuclear Reactor Pressure Vessels, and the Public Safety," 3/26/69) in reference to Brittle Fracture of Reactor Containment.

12. Experiences of Dr. Linus Pauling in trying to obtain support for his research on the beneficial effects of vitamin-C as it relates to cancer, etc.

13. Severe criticism by ORNL management of an early paper, "Radon Released from Concrete in Radiant Heating," F. J. Davis and A. F. Gabrysh, Nucleonics, January 1955.

I hope the above information will be of some assistance to your studies.

Sincerely,

Karl Z. Morgan

Karl Z. Morgan

This is a copy of the original paper as submitted by K.Z. Morgan for presentation in Neuremberg, Germany, July 5-9, 1971 at the International Atomic Energy Agency Symposium on Rapid Methods for Measuring Radioactivity in the Environment. Oak Ridge National Laboratory managment and most specifically Dr. Floyd Culler, Deputy Director had this paper recalled and replaced by one (now printed as IAEA-SM-148/45) that had all references to the LMFBR removed.

K.Z. Morgan

HEALTH PHYSICS AND THE ENVIRONMENT*

By
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Oak Ridge, Tennessee

Introduction

In speaking on the subject assigned to me for this lecture--health physics and the environment--I am sure it will not be necessary for me to give a detailed description of the science and profession of health physics. One may state simply that health physics research is the study of the effects of electromagnetic radiation on matter with particular emphasis on understanding its effects on man and his environment, and applied health physics is directed toward numerous activities designed to reduce radiation exposure of man to the lowest practicable level.. Usually, health physicists limit their research and applied activities to problems of ionizing radiation. However, a few health physicists are becoming increasingly involved with non-ionizing radiation--microwave, rf, laser (coherent), uv, and thermal problems. All of us are concerned not only with protecting man and his environment from direct and indirect forms of radiation damage but with enhancing the beneficial uses of this great source of energy or maximizing the ratio of its benefits to its risks. The environment with which we are concerned and attempting to protect includes all outside conditions and forces having an effect on the existence and development of man. We hear many discussions today about the pollution of our environment by many substances and by various forms of energy, and we are told this pollution threatens the very survival of many forms of life--including man. Thus, it is of extreme importance, and perhaps there is some urgency that major efforts be made to reduce these energy pollutants which may be classified(1) broadly as:

(1) chemical--oxides of sulfur, oxides of nitrogen, hydrocarbons, particulates, insecticides, herbicides, detergents, food additives, cosmetics, tobacco, drugs, etc.

(2) mechanical--vibrating buildings, sound, ultrasound and infrasound.

(3) biological--an imbalance of the ecosystem comprised of plants, animals insects, bacteria, fungi, viruses, etc.

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*Research sponsored by Union Carbide Corporation under contract with the USAEC.

(4) radiation--heat, light, uv, x-rays, gamma rays, alpha and beta particles, neutrons, high energy radiation, etc.

It should be emphasized throughout these discussions that all forms of energy are valuable human resources which are essential to a better way of life. Also, we should keep in mind that they are not inexhaustible, and they become pollutants of our environment only when man allows too much of them at the wrong place and at the wrong time, or when they are wasted or are no longer under proper control and when they are dumped into our environment with insufficient long-range planning and sometimes with wanton disregard of their ultimate fate or the consequences of their uncontrolled release. I will limit this discussion of health physics and the environment to a brief summary of activities of the health physicist in minimizing and assessing the risks to man from evnironmental sources of ionizing radiation and will not mention further sources of non-ionizing radiation such as microwave ovens which in some cases may be introducing serious radiation hazards into our homes. I will further limit this discussion primarily to sources of ionizing radiation associated with the operation of nuclear reactors and their related facilities. However, with this restriction, we will not lose sight of the fact that in many of the advanced countries (and especially in the United States), medical diagnostic x-ray exposure accounts for most of the population dose to man-made sources of ionizing radiation (about 95% in the United States), and it is here that the health physicist could and should be most effective in reducing unnecessary population exposure. During the past few years, I have indicated in publications(2) and hearings of the U. S. Congress(3) over 100 ways in which this medical diagnostic exposure could be reduced to less than 10% of its present value while at the same time greatly increasing the quantity and quality of medical information provided by the x-ray radiogram. Unfortunately, I have been engaged in a losing endeavour because present estimates are that the genetically significant dose, GSD, in the United States in 1970 had risen from the 1964 value(4) of 55 mrem/yr to 95 mrem/yr,(5) and the significant organ doses are more than twice these values. I certainly agree it is of the greatest importance to have international symposia such as these directed toward further reducing radiation exposure of populations from nuclear reactor operations, and we must continue to put forth a tremendous effort in order to maintain this new industry as the safest of all modern industries. However, I believe, at least in the United States, health physicists must not ignore the major population exposure problem, namely, medical diagnostic exposure which is contributing over 200 times as much GSD as the entire nuclear energy industry. In this case, I am including under the nuclear energy industry not only the occupational and non-occupational (environmental) dose from nuclear power plants but, also, that from uranium mining, fuel processing and reprocessing, radioactive waste disposal and exposures in the various laboratories that are doing research on reactors and associated facilities.

Early Health Physics Rules for Disposal of Radioactive Waste in the Environment

When health physics had its beginning at the University of Chicago in 1942 and 1943 and when plans were being made for the first nuclear reactors at Oak Ridge, Tennessee, and Hanford, Washington, there were no rules or recommendations that could be referred to as guides in establishing safe and reasonable levels for radiation exposure of the public or for the discharge of radionuclides into the environment. At Oak Ridge National Laboratory (then Clinton Laboratories), H. M. Parker and I were first to face this problem when ORNL began the discharge of low levels of radioactive waste into the environment (the Oak Ridge Graphite Reactor began operation on November 4, 1943). The only guide we had was the occupational tolerance dose rate of 0.1 R/day which, as indicated in Table I, had been recommended by the National Council on Radiation Protection, NCRP, in 1934.(6) The radioactive liquid waste containing high concentrations of radioactivity and the solutions comprising the dissolved fuel elements were retained in underground storage tanks. Intermediate and low levels of liquid, radioactive wastes were discharged into open settling ponds which emptied into White Oak Lake. White Oak Lake is an impoundment of five to seven million cubic feet of water, restricted from public access and located in the Oak Ridge reservation at a distance of about one mile from Oak Ridge National Laboratory. The outflow of White Oak Lake runs into and mixes with the waters of the Clinch River about one-fourth of a mile below the overflow at White Oak Lake dam. It is at this point that the contaminated waters mix with and are diluted by those of the public domain. Lacking any suitable guidance from NCRP or the International Commission on Radiological Protection (ICRP), Parker and I chose as our radiation protection standard a dose limit of 0.1 R/day to an imaginary microscopic organism suspended in the waters of White Oak Lake. We determined this dose theoretically and experimentally by dissolving various radionuclides in large tanks of water and making measurements of the dose received by a small dosimeter. We established this same standard, also, for airborne radioactive contamination which might result under anticipated meteorological conditions following the escape of radioactive gases or particulates from tall laboratory stacks. These stacks were used for venting, dispersing and diluting chemical off-gases and cooling air from the reactor and associated laboratory facilities, the "hot cells" and chemical, physical and metallurgical operations after the air had been passed through appropriate filter and precipitator systems. When some of the engineers, public health officials, and "behind-the-desk supervisors" heard of the dose limit we had set which was based on an exposure rate of 0.1 R/day for exposure 24 hours/day, we were severely criticized and ridiculed for such ultraconservatism. Although this early limit for environmental exposure is high in comparison with present standards, in retrospect it probably was not so reckless when we consider the waste water from White Oak Lake had an average dilution of greater than 600 just below the point of mixing in the Clinch River where it enters the public domain. Since ORNL is about 10 miles from the nearest populated area (the village of Oak Ridge), the dose rate from ORNL gaseous effluents never reach 10% of this level. On the other hand, this 0.1 R/day level was over 200 times the 170 mrem/yr population dose limit permitted in the United States today for such an operation and over 70 times the 500 mrem/yr value recommended by ICRP as an upper limit of dose to any individual in the population-at-large. Furthermore, at that time we had very scanty information regarding the body uptake of radionuclides from inhalation of air or ingestion of water contaminated with radionuclides, or from ingestion of food contaminated as a result of cycling of radionuclides in the environment. We believed in 1943 that plutonium-239 and strontium-90 probably presented serious risks from internal exposure, but the data available to assess this risk and to set permissible organ burdens or maximum permissible concentrations in air and water were almost entirely lacking. This early experience where we set health

Table I

CHANGES IN RADIATION PROTECTION STANDARDS FOR THE RADIATION WORKER

Recommended Rate*	Comments
0.2 R/day (or 1 R/wk)**	Recommended as a tolerance exposure by ICRP(7) in 1934 and continued in world-wide use until 1950.
0.1 R/day (or 0.5 R/wk)**	Recommended as a tolerance exposure by NCRP(6) on March 17, 1934, and continued in use in U. S. until 1949.
15 rem/yr (0.3 rem/wk)	Recommended as a maximum permissible dose by NCRP(8) on March 7, 1949, and ICRP(9) in July, 1950, and continued in use until 1956.
5 rem/yr (0.1 rem/wk)	Recommended as a maximum permissible dose by ICRP(10) April, 1956, and NCRP(11) on January 8, 1957.

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*The values are in addition to medical and background exposure.

**Based on a five day work week.

physics tolerance levels at what many persons thought were too low by a factor of 1,000 only to find out some 20 years later that they were too high by a factor of 200, has had a very sobering influence on some of us and guided and supported our claim that there may still be pathways and forms of radiation damage to man which are not adequately understood, and so all human exposure to ionizing radiation should be maintained as low as practicable, and no radiation exposure which can be avoided easily should be tolerated.

During the first decade of nuclear reactor operations, two contrary and often conflicting philosophies of radioactive waste disposal were developed and commonly applied--(1) dilute and forget, and (2) concentrate and retain forever. As we shall see in the papers presented at this symposium, both philosophies are actively employed today although there appears to be a trend toward the more conservative approach of concentrate and retain forever.

Typical Early Systems Applied by Health Physicists at ORNL for Disposal of Radioactive Waste Into the Environment

The methods of radioactive waste disposal at ORNL in the early period and in subsequent years have been rather typical of those used by many other large operations that dispose of radioactive waste into freshwater systems and into the atmosphere of relatively isolated air basins. The history and experience of health physics operations as they relate to radioactive waste disposal in the environment at other sites such as Hanford, Brookhaven, Savannah River, Windscale, Harwell, Karlsruhe, etc., recall many lessons worthy of review, but because of limited time and limitations of my personal experience, I will restrict this discussion primarily to health physics and its control of radiation in the environment of ORNL.

The volume of flow of contaminated water from ORNL into the settling ponds soon after 1943 became so large that these ponds were renamed retention basins because the residence time was too short for appreciable settling to take place. Automatic sampling devices were placed at the outflow of the retention basins and White Oak Lake as well as in the stacks that discharged low levels of airborne radioactive contamination into the environment. During the 28 years of operation of our Laboratory, there have been only a few minor incidents in which relatively high levels of radioactivity were introduced into the environment. These incidents include the release of fairly large "slugs" of radioactivity into White Oak Lake occasioned by errors in procedure, malfunctions of apparatus, and by unusual releases of contamination from the seepage pits, tanks and associated transfer pipes. On a few occasions due to fires, breakdown of precipitators, breakthrough of filters, and the rupture of slugs, there were releases of high levels of airborne contamination (e.g., activated uranium oxide particles, iodine-131, etc.), but on all such occasions, the environmental monitoring systems gave early warning, and our analytical procedures provided a basis on which to judge the magnitude of the risk. Papers in this symposium will discuss rapid methods for measuring radioactivity in the environment. Certainly, the early availability of sampling data and a rapid interpretation of health physics analytical results will add greatly to the safety of reactors and associated operations.

As more information became available and when recommendations for maximum permissible concentration in the air and water were provided by NCRP and ICRP, this information was used in updating the health physics radiation protection standards. Likewise, limits were set on the maximum number of curies which could be discharged per day into the air and into White Oak Lake. As time went on, our Laboratory grew in size and complexity. To the present time, there has been a total of nine reactors in operation in our area at one time or another, plus a continuous series of critical assemblies in the criticality test facility. In addition, there have been numerous physical, chemical, engineering and metallurgical operations, all of which have contributed their share to the ORNL radioactive waste. Also, there has been in use a number of areas for the temporary storage of solid, radioactively contaminated equipment ranging in size from bolts and nuts to trucks and bulldozers. Some of this equipment was decontaminated and returned to use, but in recent years more and more of the equipment contaminated with long-lived radionuclides has been taken directly to the burial grounds for permanent disposal since often the cost of decontamination exceeds the value of the equipment, and it is virtually impossible to decontaminate satisfactorily certain equipment, e.g., pipes contaminated with plutonium-239. In the history of our Laboratory, there have been three separate burial grounds in use for the disposal of ORNL radioactive solid waste. All of these grounds have been located in restricted areas within one mile of the center of the Laboratory, and they have been located in Conesauga shale formations which were purposely selected by our geologists to provide very little seepage and slow leakage and drainage of the radioactive contamination into White Oak Lake where the level of radioactivity of the water is carefully monitored on a continuing basis. During the past two decades, ORNL has interred, also, in its burial grounds radioactively contaminated waste from a number of operations outside Oak Ridge. The total number of curies actually buried in our burial facilities is not known but has been estimated at approximately 10^6 curies. Our burial grounds to date have used or placed in permanent restriction 68 acres of land, and at present we are consuming in this manner 0.8 acres per year. In the early period, some of the solid waste was reduced in volume by incineration, but radioactive waste was never burned because of the cost and the anticipated difficulty of maintaining acceptable levels of air contamination in the vicinity of the Laboratory.

As ORNL grew from its early 1,000 employees to its present population of 5,000 and as the number of sources and volume of radioactive waste increased by orders of magnitude, it became apparent that some means must be provided to reduce the amount of intermediate and high level liquid waste stored in underground tanks and that we must develop some process for treating intermediate and low level waste solutions. Such steps became necessary not only in order to reduce the potential risk of large quantities of long-lived radioactive waste stored in underground tanks at the center of the Laboratory but to meet the more conservative environmental radiation protection standards. Also, the cost of building additional underground tanks and monitoring their safe use into perpetuity was a considerable item of expense. One interesting health physics experiment during this early period was the use of open pit and rock-filled seepage trenches for the disposal of intermediate level (several μc/ml) radioactive waste. Studies of open pit operations provided much valuable information regarding retention and mechanisms of movement of various radioactive materials through the minerals in the soil. Seepage pit disposal was discontinued at ORNL, however, in 1966 because of the rapid leakage of the ruthenates and because a new concept of waste management, hydraulic fracturing, was proven to be a successful method for disposal of these wastes.

ORNL Health Physics Radioactive Waste Disposal Research

Time will not permit a review of all the early health physics radioactive waste disposal research studies such as self-sintering of radioactive waste, liquid waste disposal in salt formations, evaporation techniques and modifications of conventional lime-soda-ash waste treatment methods to accommodate them to the removal of low levels of radioactive material, so I will mention only briefly the results of two of our health physics studies which, during the past 20 years, have been productive and appear to be promising as means of removing and permanently isolating radioactive waste from our environment. Also, we believe these methods can be applied in many other suitable locations throughout the world. I refer to our studies on hydrofracturing and solid waste disposal in bedded salt formations.

As mentioned above, most of the ORNL area is underlaid by a rather impermeable layer of soft rock or clay called Conesauga shale. After an extensive series of studies, we have developed the technique(12) by which a 5 1/2" well casing is drilled to a depth of about 1,000 feet in this Conesauga shale. Then the well is cased and plugged at the bottom. A slit is sandblasted in the casing a few feet from the bottom and water is pumped into the well under pressure at about 2,500 pounds per square inch. This fractures the shale in the formations more or less in a horizontal plane. Then a mixture of clay, fly ash, cement, intermediate level radioactive waste and chemical compounds to control the rate of solidification (mostly sugar) is pumped under pressure into the fracture in the shale. Typically, it spreads out in a thin, pancake shape several millimeters in thickness to a radius distance of about 150 meters. Shortly thereafter, the cement mixture sets into a hard formation which will be isolated from man's environment for thousands of years. About six months later, another slot (perhaps 10 feet above the previous one) is cut in the well casing, and the hydrofracturing procedure is repeated. Each batch of disposed radioactive waste consists of about 80,000 gallons and commonly contains about 40,000 curies, much of which is strontium-90 and cesium-137 with small quantities of transuranium radionuclides (e.g., 0.2 mg/gal of plutonium-239). This method of isolating radioactive waste from the environment can be used only where there is a suitable, relatively impermeable geological formation which can be hydrofractured in more or less a horizontal direction. It should not be used except where adequate confirming test wells have been drilled. Although we have limited the hydrofracturing technique to the disposal of intermediate level waste (e.g., sludge from the waste treatment plant and from the waste evaporator), it is a method which I believe could be extended safely in the Oak Ridge area to the disposal of high level radioactive waste (all health physicists do not agree on this point) in Conesauga shale and other suitable impermeable formations. This extension perhaps would be more acceptable if the formations selected were below sea level. The thin "pancakes" of solid waste are ideal for disposing of the heat that would be generated from high level radioactive waste. By hydrofracturing to the present time (1971), ORNL has disposed of about 600,000 gallons of concentrated, intermediate level, liquid radioactive waste containing about 400,000 curies.

After many years of health physics research(13) on the disposal of solid radioactive waste in bedded salt formations in Kansas, this method has been sufficiently proven in its safety and practicability aspects that preparations are now under way by the USAEC to establish a national waste disposal repository near Lyons, Kansas. Our health physics studies have indicated the safety of this method of disposal by confirming the integrity of the salt, the low chlorine formation, the slow deformation of the salt columns in the mine when under added stress of temperature and radiation and the ability of the salt formations to dissipate adequately the heat from the radioisotopes and from the stored energy (Wigner energy) in the salt structures. The operation of this facility will consist of excavating rooms in the salt formations and burying containers of solid radioactive waste in holes that have been drilled in the floors of these rooms. Remote control equipment and specially designed vehicles are used in these operations to reduce exposure of the mine operators to negligible levels. After a room floor has been filled with radioactive sources, it will be backfilled with loose salt and abandoned. In a matter of a few decades, the loose salt in the backfilled rooms will be compressed and annealed into a solid mass again, thus encasing and sealing the radioactive material in a self-sealing formation where it will be isolated safely from the environment for thousands of years while it decays to stable isotopes. We are confident of this course of events because the salt could not have been here in the first place unless during the past millions of years it has been isolated from large volumes of water. This project is currently being considered in the U. S. Congress. If it is authorized for fiscal year 1972, acquisition of the site and detail design will commence about October, 1971, with construction beginning in the spring of 1973. If the presently envisaged schedule holds, full disposal operations will commence in 1976 and will continue through the end of the century. During this period, the facility will handle and store all of the solidified, high level fission product wastes from the entire U. S. nuclear power industry plus about 20 million cubic feet of packaged solid wastes contaminated with long-lived transuranium isotopes generated primarily at AEC installations. In the meantime, salt disposal of radioactive materials has been adopted and is currently being practiced for the permanent isolation of low-level solid wastes in the Asse II mine near Hanover, Germany.

Environmental Sampling Techniques Used in Early Health Physics Programs

I am sure it is clearly understood without repeating at this Symposium on Rapid Methods for Measuring Radioactivity in the Environment that the best way of handling situations requiring rapid measurements in emergencies is to apply the first health physics principle; namely, use appropriately designed equipment kept in proper maintenance and use well-thought-out procedures by adequately trained personnel to avoid emergencies and accidents of all types--it is much easier, less costly and better for public relations to avoid accidents than to provide adequately for them after they have occurred. Some accidents lead to a loss of life and property which at times are difficult if not impossible to replace. However, we must never forget that due to imperfections in machinery and fallacies of man, if an accident can happen, it eventually will happen. The health physicist must be prepared in advance to handle such an accident swiftly and adequately. One of the best ways of implementing the capability for handling emergencies is to build into existing health physics environmental sampling programs systems and techniques which can be adapted to rapid analysis. In this symposium, new equipment and techniques for rapid analyses will be discussed by others, so I will limit this part of my discussion to mentioning a few of the early instruments and environmental sampling techniques in order for us to appreciate better from the papers that follow how old equipment and well tried techniques can be and have been modified and augmented to provide the required speed of sample analyses during the time of an emergency.

If there is an explosion in a reactor or chemical facility, it is likely to be apparent immediately that there is an emergency requiring rapid environmental sampling, but, unfortunately, one cannot always be sure by what means it will become apparent first that there is a radiation emergency requiring information from rapid sample analysis. No one system of data collection and sample analysis is adequate, and usually input from many sources of information is required as an acceptable basis of confidence in the results and their interpretation. Health physics surveyors in various areas of an operation are frequently the first to sound the alarm of an impending environmental contamination emergency. Sometimes it is the output information received at the central instrument panel of the facility that sounds the first warning of high activity or a rapidly rising activity in an exhaust stack, holding pond, or downwind in the neighborhood of a health physics monitoring station. Frequently, many of our area monitoring, parameter monitoring, and outlying monitoring stations provide early readings which caution the need for certain modifications in plant operations or indicate a developing inefficiency in a filter system, thus giving warning of impending events or accidents which are avoided by immediate remedial action on the part of the health physicist and cooperating plant employees. Such warnings may come from indirect evidence such as the buildup of a radionuclide in river mud, the increase in levels of radioactivity in fish or crustaceans in the river or the radioactivity in birds that may be using the settling ponds for a stopover during their migration. Sometimes there are sharp rises in the number of radioactive particles on the collection trays, gum paper collectors and filter paper of the air samplers. By having a proper distribution of such samplers about the parameter of an operation, it is easy very quickly to differentiate between the rises in activity due to plant operations and those due to weapons testing in some remote part of the world. Regardless of the source of information which suggests the development of an environmental contamination problem, the methods of rapid sample analysis which will be discussed in this symposium should be well developed and on a standby operational basis ready to be placed in operation immediately in providing quantitative analytical information at the earliest possible moment. One extremely useful method of early rapid location of areas of high radioactivity and of giving some information of the magnitude of the contaminant in various parts of the environment and surrounding communities is that of aerial surveys. Some of the earliest work in the development of airborne radiation monitoring equipment was done (1949) by Davis and Reinhardt of our Health Physics Division.(14) These instruments were developed for sampling the air as well as measuring the radiation shine from the ground. In more recent years, these instruments have been improved and developed such that they have extreme sensitivity and reliability for locating weak sources on the ground and identifying the radionuclide involved. As would be expected, most such equipment can be conveyed equally well by truck or boat, thus bringing the sampling and measuring devices to the samples in situ in time of emergency and providing very rapid feedout of information to those who must make decisions which may involve evacuation, restrictions in the use of certain food and water supplies, etc. Such equipment must be ready to operate reliably on a moment's notice if it is to serve its most useful function in time of emergency, i.e., to evaluate the seriousness of environmental contamination.

During the past 20 years, all major reactor laboratories in the world have been developing and implementing the use of various types of nuclear accident dosimeters. Although the detectors used in the various systems are quite different and serve other functions from those designed to assess radioactivity in the environment, the auxiliary counting equipment and other laboratory facilities used in processing nuclear accident dosimeters and evaluating the results are very similar and certainly in some cases they are the same as those used in rapid methods of measuring radioactivity in the environment. Perhaps in some of the papers that follow, this tie-in of equipment and facilities which tends to reduce the cost of preparedness of a laboratory to handle adequately emergencies (both foreseen and unforeseen) will be mentioned by some of the subsequent speakers. For the past several years, those responsible for nuclear accident dosimetry at the various nuclear facilities in many of the countries of the world have been meeting at our health physics reactor facility and at similar facilities in other countries for the purpose of cross-comparing and calibrating the various emergency dosimeter systems. I believe these intercomparison and calibration studies have been most useful because each year these programs are conducted we find less deviation in instrument results and more reliable and rapid feedout of information following exposure of the nuclear accident dosimeters to various types and combinations of ionizing radiation. Perhaps it would be in order to suggest that it might serve a useful function if there could be similar cross-comparisons and calibrations of rapid methods for measuring radioactivity in the environment.

Health Physics Must Aid in Minimizing Release of Radionuclides to the Environment

ICRP(15) in its publications had indicated that it would be virtually impossible for a health physicist to follow in detail all the approximately 800 radionuclides that could be released from a reactor and its associated operations. Similarly, it is indicated the impossibility of following all the food chains in the environment and of studying carefully all the various population groups. Fortunately, it has shown that such comprehensive studies are not necessary in assuring adequate protection of those living in the environment of these operations. It has provided a simplified procedure that health physicists can follow by which they can judge the adequacy of their environmental monitoring program. It involves three steps: (1) determination of the critical radionuclide(s) that may be released routinely or during accidents involving the reactor or associated facilities; (2) a study of the critical pathways by which these radionuclides may result in appreciable radiation exposure to man; and (3) an evaluation of exposure to the critical segment of the population.

Health physics responsibilities begin long before the construction of a reactor and associated facilities when background measurements are made which are to serve for normalization and comparison of all future measurements. The senior health physicist should be involved in a major way in the purchase of radiation protection devices and instruments, the establishment of procedures which can be expected to minimize occupational and environmental exposure and in the preparation of potential accident evaluation reports in which assessments are made of the maximum credible accident and its consequences. I believe all too often it is not recognized soon enough that the senior health physicist can play a major role in developing the proper public attitudes and assuring in the eyes of the public the acceptability of a nuclear power plant or associated facilities in its community. The health physicist who is encouraged to play a major role in the reactor safety program will develop a list of radionuclides in the order of decreasing priority in terms of the part they would be expected to play in causing exposure to employees and to persons living in the neighboring environment during routine operations of the reactor and associated facilities and on the rare occasion when a major accident occurs.

One cannot state with certainty the consequences of low level exposure of populations from routine operations of reactors or exposure during the unlikely event of a major accident. In assessing the consequences of any radiation exposure, ICRP(16) takes the position that the most prudent assumption is that there is a linear relationship between dose and effect. During the last several years, a large mass of data has been collected in several countries which, although it does not prove a linear relationship between dose and effect, suggests very strongly it is reasonable to assume this relationship. Hempelmann(17) has indicated from his studies of several population groups ranging in thyroid dose from 1200 rad down to 20 rad that (1) the dose response of thyroid tumors is linear in the low dose range, and (2) there is no threshold or at least the threshold is below 20 rad. Stewart and Kneale,(18) Brian MacMahon(19) and many others(20) have reported an increased incidence of leukemia of 30-50% among children whose mothers were exposed to 1 or 2 rad of diagnostic dose during pregnancy. Although studies of Russell(21) have indicated a rate dependence for exposure to mice below dose rates of 5,000 R/hr, the average drop-off in point mutation frequency at low dose rates for the two sexes is only by a factor of about 1/6, and there is no evidence of any further drop-off in mutation frequency at lower dose rates. Often we see reference to the fact that the risk of radiation exposure to the population from the operation of a nuclear power plant is negligible and not worthy of consideration, but I believe such broad-sweeping qualitative statements are meaningless and worthless for our own thinking and in convincing the public. It is for this reason I prefer to deal with numbers such as those provided by the ICRP(22, 23) on the assumption of a linear relationship between dose and effect. When making estimates of the radiation risk to the population from the nuclear energy industry, I think in all fairness we should make comparisons also of the radiation risk to the population from the other more important sources of ionizing radiation exposure. In Table II I have compared the risk from medical diagnosis in the United States with that of routine exposure in the nuclear energy industry. In obtaining the figures given in this table, I have used the preliminary estimates from the 1970 survey of the U. S. Public Health Service(5) of the genetically significant dose to the United States population from medical diagnosis. In the case of somatic exposure, I have used the data from the 1964 survey of the U. S. Public Health Service. Since the GSD went up from 55 mrem/yr(4) in 1964 to an estimated 95 mrem/yr in 1970, I probably have underestimated the risk of somatic damage from medical diagnosis by a factor of 2. The larger figure of genetic deaths

Table II

COMPARISON OF CONSEQUENCES OF X-RAY DIAGNOSTIC EXPOSURE PRESENTLY RECEIVED BY THE U. S. POPULATION WITH THE CONSEQUENCES OF A CONTINUOUS EXPOSURE FROM ALL NUCLEAR INDUSTRIES OF 0.5% OF THE ALLOWED 170 MREM/YR (0.85 MREM/YR)

Types of Radiation Damage	Consequences of Medical X-Ray Diagnostic Exposure Presently Received by U. S. Population (deaths/yr)	Consequences of Hypothetical Exposure of 0.85 mrem/yr to U.S. Population from Nuclear Industries (deaths/yr)
Genetic	1900* to 76,000**	3* to 120**
Leukemia	500	3
Thyroid Cancer		0.2*** to (2)
(a) from dental x-rays	16*** to (160)	
(b) from thorax x-rays	2*** to (20)	
Other Cancer	500	3
Life Shortening	1200	8.5
Total Deaths (~)	4100 to 78,000	18 to 140

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*This includes only first generation genetic deaths and assumes the factor of 1/6 does not apply to the high dose rates ordinarily used in medical x-ray diagnosis but does apply at the very low dose rate of 0.85 mrem which would be delivered during the year.

**This includes genetic deaths in 40 subsequent generations and assumes the genetic recovery factor of 1/6 does not apply in the case of man for medical diagnostic exposure but does apply at the very low dose rate of 0.85 mrem/yr.

***This is assuming 90% of thyroid cancers are cured by medical treatment and so are not included in this number. The numbers in parentheses include all thyroid cancers.

per year (76,000) from medical diagnosis is the number of genetic deaths introduced into the population per year from the GSD of 95 mrem/yr. Most of these deaths would make their appearance in future generations. By comparison, it is assumed the present dose to the U. S. population from all the nuclear energy industries is less than 0.5% of the 170 mrem/yr suggested by ICRP(16) as an average GSD to a population. On this basis and according to the linear hypothesis, there would be in the U. S. 18 deaths/yr and 140 deaths introduced into the population/yr. These numbers are the deaths that would be expected on the linear hypothesis as a consequence of both occupational and environmental exposure (non-occupational exposure) from the entire nuclear energy industry (i.e., from operations in all the national laboratories doing reactor research, all exposure from the nuclear power plants, and from the plants fabricating and reprocessing reactor fuel elements and from the radioactive waste disposal operations). In this case, deaths from somatic damage resulting from exposure of workers in the uranium mines of the Colorado Plateau are excluded from Table II but included in the deaths from high exposure rate in Table III. Table IV indicates what one might estimate to be the consequences of a serious reactor design accident in which a million persons are exposed to 10% of the AEC design exposures. The seriousness of such a risk depends, of course, on the probability of such an accident. Although in some countries the probability of such an accident is estimated to be extremely low (less than 10^{-6}), I am convinced from the data I have seen that this risk probability is in the neighborhood of 10^{-4} for present power reactors (pressurized water reactor and boiling water reactor)* now in operation in our country. Using this risk probability and assuming we will have an average of only 200 power reactors in the United States during the next 50 years, the risk of six deaths/yr or 50 deaths introduced into the population/yr from nuclear power plant accidents dwindles into insignificance in comparison with other commonly accepted risks.

I believe there are many kinds of action which can be taken to reduce risks to persons living in the environment of nuclear power reactors. In Table V, I have summarized developments which I believe would greatly reduce these risks. Although some executives(24) of electric power companies are advocating moving nuclear power reactors into our big cities, I believe this would be a very unwise move until we have more reactor experience and until we can be assured the probability of a major nuclear power reactor accident is exceedingly low and 10^{-5} or less. Although in Table IV I have indicated the risk from nuclear power plant accidents is probably only about 300 deaths per accident and 2300 deaths introduced into the population per accident, this number could easily soar by one or two orders of magnitude if future reactors were located in densely populated areas. Time will not permit discussion of all items mentioned in Table V, but a few words of explanation may be in order. The so-called China syndrome refers to the type of reactor accident in which there is a core meltdown, and the heat generated in the core causes it to work its way on down several feet in the earth toward China. For this and other reasons, some have questioned the advisability of continuing to increase the size of nuclear power plans (> 1000 MW(e)) and have suggested a better alternative might be to build reactor parks or power complexes consisting of a series of smaller nuclear power plants (< 1000 MW(e)). The common mode failure refers to the type of accident which is relatively common and is attributable to the fact that common components or systems are

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*Gas-cooled reactors are not included in this discussion because they are not operating in the United States at present as nuclear power reactors.

Table III

DEATHS/YR IN THE UNITED STATES FROM ALL SOURCES OF EXPOSURE TO IONIZING RADIATION (ESTIMATES BASED ON ICRP LINEAR HYPOTHESIS)

	Deaths/Yr	Deaths Introduced/Yr to Population
Low Exposure Rate		
Natural Background	5000	(20,000)
Weapons Fallout	30	(160)
Nuclear Industry (Routine Operations)	20	(140)
All Other Exposure	10	(70)
High Exposure Rate		
Medical (Diagnostic)*	4000	(80,000)
Medical (Therapeutic)*	800	(8000)
Uranium Miner Lung Carcinoma**	10	
Nuclear Power Plant Accidents**	6	(50)
Radiation Criticality Accidents*	0.3	
Total	10,000	(110,000)

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*Average dose rate assumed to be sufficiently high that the factor of 1/6 does not apply.

**Average dose rate assumed to be sufficiently low that the factor of 1/6 applies.

Table IV

CONSEQUENCES OF AN EXTREMELY RARE HYPOTHETICAL REACTOR DESIGN ACCIDENT

Type of Radiation Damage	Consequences of Exposure of 10^6 Persons to 10% AEC Design Exposures Δ	
Genetic	40*	(1700)**
Fatal Neoplasms		
Leukemia	40	
Other Cancers	40	
Thyroid Carcinoma	40 †	(400)
Life Shortening	120††	
Total	300 to 2300	

Δ This assumes 10^6 persons are exposed to an average of 10% of the AEC design exposures (i. e., 10% of 25 rem to total body and 10% of 300 rem to thyroid). This assumes the linear hypothesis of ICRP applies.

*This includes only the first generation genetic deaths and assumes the factor of 1/6 applies.

**This includes genetic deaths in 40 subsequent generations and assumes the factor of 1/6 applies.

†This includes only 10% of the thyroid carcinomas on assumption 90% respond successfully to medical treatment.

††This assumes 70 years of life shortening corresponds to one death.

Table V

ACTIONS RECOMMENDED TO REDUCE RADIATION RISK OF NUCLEAR POWER REACTORS

(1) Ensure the continued isolation of reactors (BWR, PWR, LMFBR) from densely populated areas.

- (a) Consider underground and underwater caisson construction.
- (b) Establish remotely located nuclear power parks or complexes.
    - (i) Develop high voltage a.c. and d.c. transmission to reduce line losses.
    - (ii) Develop cryogenic transmission to reduce line losses.
- (c) Place land in neighborhood of reactor permanently on a limited use basis.

(2) Reduce risks of power reactor accidents and minimize their consequences.

- (a) Reduce the probability of major reactor accidents to 10^{-5} or less.
- (b) Require a satisfactory secondary containment.
- (c) Require a secondary shutdown system.
- (d) Avoid the possibility of autocatalytic reactions.
- (e) Avoid the China syndrome.
- (f) Avoid the common mode failure.
- (g) Plan an appropriate disaster control program.

(3) Move toward safer types of reactors such as the MSBR rather than the LMFBR.

- (a) The MSBR could be designed for continuous removal of the fission product inventory.
- (b) The thermal breeder, MSBR, appears to be inherently safer than the fast breeder, LMFBR.
- (c) Uranium-233, the fissile fuel of the MSBR, is much less hazardous in terms of radiotoxicity than plutonium-239, the fissile fuel of the LMFBR.
- (d) The inventory of the more dangerous transuranium isotopes and fission products in the MSBR is less than in the LMFBR for the same MW(e) days.

used which fail because of a common insult such as a rise in temperature or change in pressure. As indicated in Table 5, I believe the molten salt breeder reactor, MSBR, offers many advantages over the liquid metal fast breeder reactor, LMFBR, from the standpoint of safety and a much reduced potential for a serious reactor accident. I recognize the risk of continuous removal of fission products and non-fissile transuranium isotopes from the MSBR, but I believe with sufficient research these techniques can be developed so that the risks are minor. It seems to me that the risk of a major accident from an LMFBR containing many billions of curies of long-lived fission products and transuranium isotopes is far greater than the risk of an MSBR containing only a few thousand curies of these products (because the others would have been removed more or less on a continuous basis). Tables VI and VII indicate the comparative inventories of the more important long-lived fission products and transuranic elements (plus thorium), respectively, in these two reactor systems. These inventories are used in obtaining the relative reactor radiation risk, RRRR, of the MSBR and the LMFBR. As a result of such comparisons I do not wish to appear to downgrade the LMFBR in favor of the MSBR but rather to suggest there are other reactor systems which are inherently safer and which with research can be made far safer than any of the reactor systems now under construction. So long as this is the case, I feel the health physicist has no other choice than to urge developments in this direction.

Health Physics and Radiation Ecology

The previous section dealt primarily with problems relating to critical radionuclides, and this section deals with the problem of critical pathways and the fate of these radionuclides once they are released into the environment. When E. G. Struxness, Orlando Park and I almost 20 years ago established the first radiation ecology research program of the AEC at Oak Ridge National Laboratory, we ran into almost unbelievable opposition. This was at a time when few people knew the meaning of the word "ecology" and before many persons recognized the necessity of having more information on the critical pathways of these radionuclides in various food webs, and especially the pathways leading to man. The first criticism of our early proposal for a radiation ecology program was, "Why should we be concerned about these ecosystems? Certainly man wasthe most important element of concern in the environment. So long as we protected him, we need not be concerned with the effects of radiation on other organisms." The fallacy of such an argument is so obvious today that it needs no comment. All of us are acutely aware than man can be eliminated from the ecosystem indirectly and perhaps just as easily as by the direct effects of environmental insults such as excessive ionizing radiation. Another criticism was, "It takes 10^5 or more rems to destroy bacteria and fungi, so why should we be concerned when it takes only about 600 rem to destroy man? So long as man is not harmed, we need not worry about these other elements of the environment." Since that time, of course, it has been learned that it takes relatively low doses to eliminate many microorganisms in the environment. In some cases, it may take large doses to destroy the individual but relatively low doses to prevent its reproduction. Today, we know that even some plants such as the pine tree have a mid-lethal dose about equal that for man. Another response which in retrospect seems difficult to believe was, "Why not just dilute the radionuclides by a factor of 10^{-6}, dump them in the rivers and forget about them?" Our answer then was we thought there might be factors of reconcentration of a hundred or more, and we did

Table VI

RELATIVE REACTOR RADIATION RISK (RRRR) OF THE MSBR AND LMFBR FROM THE INVENTORY OF FISSION PRODUCTS*

Radionuclide	Curies in Reactor	Grams in Reactor	$(MPC)_a$ 168 hr/wk	RRRR
		MSBR		
^{133}I	9.7×10^7	86.6	10^{-8}	3.80×10^{-2}
^{131}I	2.4×10^7	1.94×10^2	3×10^{-9}	3.14×10^{-2}
^{90}Sr	1.2×10^5	8.28×10^2	4×10^{-10}	1.18×10^{-3}
^{103}Ru	5.3×10^6	1.72×10^2	2×10^{-7}	1.04×10^{-4}
^{106}Ru	8.8×10^4	26.1	3×10^{-8}	1.15×10^{-5}
^{133}Xe	7.0×10^3	3.76×10^{-2}	3×10^{-6}	9.15×10^{-9}
^{85}Kr	(1.25)**	3.18×10^{-3}	3×10^{-6} (^{85}Kr) 1×10^{-6} (^{85m}Kr)	2.39×10^{-12}
				7.07×10^{-2}
		LMFBR		
^{131}I	8.2×10^7	6.61×10^2	3×10^{-9}	0.107
^{133}I	1.2×10^8	1.07×10^2	10^{-8}	4.71×10^{-2}
^{90}Sr	1.3×10^6	8.97×10^3	4×10^{-10}	1.27×10^{-2}
^{106}Ru	6.3×10^7	1.87×10^4	3×10^{-6}	8.24×10^{-3}
^{103}Ru	1.4×10^8	4.53×10^3	2×10^{-7}	2.75×10^{-3}
^{133}Xe	1.5×10^8	8.06×10^2	3×10^{-6}	1.96×10^{-4}
^{85}Kr	3.2×10^5	8.14×10^2	3×10^{-6}	4.18×10^{-7}
				17.8×10^{-2}

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*Compiled with the help of M. J. Bell and M. R. Ford.

**Also includes 23% ^{85m}Kr activity.

Note: The above values apply only to inventories of fission products contained in the reactors operated . 33,000 MWd and not to inventories in associated fuel reprocessing plants. The author (KZM) believes the risks of release of fission products as a result of major accidents can be made much less in reprocessing plants than in the reactors. The consequences of a major accident in the reprocessing plant depend considerably on the fuel storage and reprocessing cycles. However, if the risks of such accidents were equal (or greater) in the reprocessing plants than in the reactors, the over-all RRRR could be about the same for the MSBR and the LMFBR.

$$\frac{1.53\times10^{5}}{6\times10^{-13}} = 0.255\times10^{18}$$
$$\approx 3.92\times10^{-18}$$
$$RRRR = \frac{\text{Curies in Reactor}}{(MPC)_a}\times 3.92\times10$$

Table VII

RELATIVE REACTOR RADIATION RISK (RRRR) OF THE MSBR AND LMFBR FROM THE INVENTORY OF THORIUM AND TRANSTHORIUM ELEMENTS*

A Radionuclide	B Curies in Reactor	C Grams in Reactor	D $(MPC)_a$	E RRRR
		MSBR		
^{238}Pu	3.32×10^{3}	200	7×10^{-13}	1.85×10^{-2}
^{233}Pa	4.31×10^{8}	2.10×10^{4}	2×10^{-7}	8.45×10^{-3}
^{233}U	1.17×10^{4}	1.23×10^{6}	2×10^{-10}	2.29×10^{-4}
^{234}U	2.72×10^{3}	4.44×10^{5}	2×10^{-10}	5.33×10^{-5}
^{237}Np	11.7	1.70×10^{4}	10^{-12}	4.59×10^{-5}
^{239}Pu	1.53	25.0	6×10^{-13}	1×10^{-5}
^{232}Th	7.70	6.94×10^{7}	10^{-11}	3×10^{-6}
^{236}U	7.64	1.20×10^{5}	2×10^{-10}	1.50×10^{-7}
^{235}U	0.248	1.16×10^{5}	2×10^{-10}	4.86×10^{-9}
				0.0273
		LMFBR		
^{238}Pu	4.81×10^{5}	2.90×10^{4}	7×10^{-13}	2.69
^{241}Pu	1.58×10^{7}	1.41×10^{5}	3×10^{-11}	2.07
^{240}Pu	1.97×10^{5}	8.70×10^{5}	6×10^{-13}	1.29
^{239}Pu	1.53×10^{5}	2.49×10^{6}	6×10^{-13}	1
^{242}Cm	2.32×10^{6}	700	4×10^{-11}	0.227
^{241}Am	3.50×10^{4}	1.10×10^{4}	2×10^{-12}	0.0686
^{244}Cm	3.20×10^{4}	400	3×10^{-12}	0.0418
^{243}Am	1.11×10^{3}	6.00×10^{3}	2×10^{-12}	2.18×10^{-3}
^{242}Pu	246	6.40×10^{4}	6×10^{-13}	1.61×10^{-3}
^{237}Np	1.37	2.00×10^{3}	10^{-12}	5.37×10^{-6}
^{238}U	14.5	4.23×10^{7}	3×10^{-11}	1.90×10^{-6}
				7.39

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* Compiled with the help of M. J. Bell and M. R. Ford.

Note: The above values apply only to inventories of thorium and transthorium elements contained in the reactors operated ~ 33,000 MWd and not to inventories in associated fuel reprocessing plants. The author (KZM) believes the risks of release of thorium and transthorium elements as a result of major accidents can be made much less in reprocessing plants than in the reactors. The consequences of a major accident in the reprocessing plant depend considerably on the fuel storage and reprocessing cycles. However, if the risks of such accidents were equal (or greater) in the reprocessing plants than in the reactors, the over-all RRRR could be about the same for the MSBR and the LMFBR.

$$\frac{7.39}{.0273} = 270$$

not feel this would be a safe procedure. Today, we know that phosphorous-32 can be concentrated in skeletons of fish, and iodine can be concentrated in milk by factors of 10^4 to 10^5 above those in the environment (i.e., in the water and air, respectively), and so rather generous dilution factors might be lost under such environmental circumstances. The response we received to our proposal for a radiation ecology program which seemed just as absurd then as it does today was, "Why worry about destroying bacteria, fungi, arthropods, etc.? It would be a good thing to get rid of them." Fortunately, today, it does not require any great effort to convince those in authority of the need for radiation ecology. In fact, these programs are receiving very strong support by the USAEC and other government agencies. I consider such programs an important part of health physics. Most biological research with mammals is conducted with inbred animals while man is a wild species, and this alone speaks strongly for ecological studies of various forms of life in a wild environment.

In this short discussion, it would be impossible even to list all the interesting highlights of the Oak Ridge National Laboratory radiation ecology program. One study of considerable interest was concerned with a common redworm (Chironomus tentans larvae)(25) which lives in the mud of White Oak Lake. These worms, with an average life cycle of about 30 days, have been exposed at an average dose rate of 230 rad/yr for about 150 generations, and we thought it would be of interest to study the effects of these relatively large doses of radiation on many generations of these organisms. Studies were conducted of the chromosomal aberrations in the salivary glands of these worms, and it was found that this radiation exposure apparently has increased the variety of these aberrations but not the number. The newly occurring aberrations are eliminated by selection or genetic drift and are not maintained in the gene pool of the population. In order to study a comparable population of humans, investigations would have to go back thousands of years before the time of Christ. Perhaps these studies suggest that in a mammalian population radiation would be expected to increase the variety of chromosomal aberrations but that there would be on the average only a certain number of new aberrations plus the endemic ones that could be tolerated in a surviving population. The study of freshwater clams(26) showed straition buildup of strontium in the shells which was very interesting and suggested this biological dosimeter as a mechanism for estimating the past history of a stream in terms of its burden of strontium-90. We never learned why the pipe-organ mud-dauber wasps(27) seem to prefer to build their nests of radioactive mud from White Oak Lake while the black-and-yellow mud-dauber wasps seem to carefully avoid this radioactive mud. Neither was it understood why 10,000 rad of cobalt-60 γ-radiation reduces the mean life of caged bees(28) in laboratory experiments, but it requires only 5,000 rad to completely destroy a bee hive consisting of a highly organized social environment such as that in which man lives. I do not wish to leave the impression that radiation ecology only raises questions and does not answer them; quite to the contrary, it has provided extremely valuable guidance in many problems relating to radioelements in the environment. As can be expected in an active research program, however, it has raised many important questions which have not yet been answered but perhaps would never have been asked until too late unless such programs were in existence. Once it is known which are the more important radionuclides likely to be released into the environment, radiation ecology studies in the laboratory and in the field are the only satisfactory means by which one can be assured the critical pathways leading to man will not concentrate them in such a manner as to seriously damage man's environment including his food web and man himself.

Health Physics Has a Major Role in Identifying Critical Segments of the Population

As indicated above, the third requirement of ICRP for an adequate radiation environmental program associated with a nuclear power operation is that of identifying the critical segment of the population. This, I believe, is the most important of the three parts of the problem as defined by ICRP, but in some respects it is the most difficult. The critical segment of the population may be a certain age group; it may be the in uterally exposed individuals or it may be persons with certain diseases. The critical population may be individuals in whom the critical body organ is small, and yet such individuals have the same uptake of the radionuclide as the average individual leading to higher concentrations in this organ. A case in point is iodine-131 which concentrates in the thyroid of the young child who has a thyroid that is about 10% the mass of the adult thyroid. In addition, the child may drink more iodine-131-bearing milk and have a higher thyroid radiosensitivity than the adult. The critical segment of the population may be a group of people who have certain customs or religious habits that cause them to eat certain food with high concentrations of one or more of the radionuclides. Some of the Welsh people, for example, eat seaweed contaminated with radionuclides discharged from the Windscale operation into the Irish Sea. If a radionuclide adds appreciably to the genetic dose, the critical segment of the population obviously consists of the persons of childbearing age. The weight and sex of an individual can be important factors determining the uptake, distribution and radiosensitivity of an individual. Much of the information needed in identifying the critical segment of a given population may be missing, and this means certain experimental data must be collected from the population which is to be exposed. The internal dose handbook of ICRP(29) contains useful data on the uptake, distribution and elimination of radionuclides in the human body but almost no data on the variation of these parameters with age, sex and eating habits of the population. ICRP has under preparation a "Reference Man Report" (Snyder, chairman), and this should provide a wealth of data for making some of the calculations necessary in identifying critical members of the population. One of the finest programs which has been conducted leading toward the identification of the critical segments of the population was that by Honstead at Hanford.(30) I would urge health physicists to read the reports describing this program and make similar measurements in their locality to enable them to estimate the dose received by individuals in the environment of reactor operations. At Hanford, a mobile shadow-shield instrument mounted in the back of a van truck was used to measure the body burdens of plant employees, school children, persons selected at random from the population and fishermen with diets that might be expected to lead to unusually large internal doses from the accumulation of radionuclides discharged by the Hanford plants into the Columbia River. This study showed not only which persons are likely to be the critical segments of the population but provided information on the critical pathways of radionuclides to these populations. For example, studies indicated the significance of eating fish, eggs, chickens, wild game, milk and leafy fresh vegetables that would be expected to accumulate relatively large concentrations of certain radionuclides from the Hanford environment. A very valuable and perhaps unexpected dividend of the Hanford program was the great improvement in public relations. Through this program, the population in the environment of Hanford was able to participate in the health physics evaluation of the radiation problem and was given a better basis on which to judge the relative risk of radioactive contaminants in the environment. They learned that the dose they received from the Hanford operations was only a part of that from fallout due to testing of nuclear weapons and a small fraction of that from medical diagnosis.

Finally, I would like to point out that ICRP has set the population dose limit primarily in terms of 500 mrem/yr to the individual and an average of 170 mrem/yr to a given population. In setting these radiation protection standards some years ago,(16, 31) ICRP gave special consideration to the genetic risk or the genetically significant dose. More recent evidence, however, has indicated the ratio of the somatic to the genetic risk may be 30 to 60 times greater than we thought some time earlier. This increased concern for somatic damage derives from the fact that Russell's(21) experiments indicate the mutation frequency decreases by a factor of 1/6 at low dose rates and the fact that the total radiation-induced malignancies may be five to 10 times the radiation-induced leukemia which some years ago was considered to be the principal radiation-induced malignancy of concern other than bone tumors. Also, the high incidence of malignancies among children diagnostically exposed to 1 to 3 rem in uteral suggests that a population dose to the individual of 500 mrem/yr probably does not offer much margin of safety.

In conclusion, I believe the present radiation protection standards are reasonable and satisfactory in spite of the fact that they do not contain a large factor of safety. I must be quick to state, however, that I believe they are acceptable only so long as we continue our present practice of maintaining occupational exposures and exposures of members of the population-at-large far below the recommended dose limits. As indicated above, the average dose received by the population in the United States at present from nuclear power operations is less than 1 mrem/yr in comparison with an estimated genetically significant dose of 95 mrem/yr and a significant organ dose of about 200 mrem/yr from medical diagnosis. I believe it is of the utmost importance in our country that medical diagnostic exposure of the population be included as part of the 170 mrem/yr allowed to the average member of the population. This inclusion would not be possible in the United States at present but would introduce no serious administrative difficulties in most of the more advanced countries. For example, in the United Kingdom the genetically significant dose in 1957 was estimated to be only 14 mrem/yr. I believe it would be extremely helpful if an appropriate authority in each of the major countries would pro rate this 170 mrem/yr to the various sources of population exposure. In so doing, I would urge that a large fraction of the 170 mrem/yr (and at least 50 mrem/yr) be set aside as a reserve for future unanticipated applications. It would seem to me a reasonable goal would be to assign this 170 mrem/yr as follows: 5 mrem/yr for diagnosis; 10 mrem/yr for therapy; 10 mrem/yr from the nuclear energy industry; 5 mrem/yr from other environmental exposure, and 10 mrem/yr from occupational exposure including that in the nuclear energy industry; the rest, 130 mrem/yr, could be assigned to reserve. Perhaps it will be toward the end of the century before such a goal can be attained in our country but not so in other countries. For example, Adrian(32) has indicated the genetically significant dose in the United Kingdom could be reduced to 2 mrem/yr if all the radiological departments employed the techniques already in use in 25% of the departments employing better techniques and facilities.

I foresee in the years ahead that health physicists will play an even more important role in minimizing energy pollution of the environment. By convincing the public that nuclear power plants are far safer than fossil fuel plants, they can almost eliminate one of the major and more harmful sources of pollution, oxides of sulfur. Very importantly, they can at the ~~same time reduce~~ reduce radioactive contamination of the environment. For example, studies of Martin, Howard and Oakley(33) have shown that the radiation dose per megawatt of electricity from the radioactive daughter products of uranium and thorium to persons living in the neighborhood of a modern, coal-fired plant such as Willow Creek can be 10 to 100 times that to persons living in the neighborhood of a pressurized water reactor such as the Connecticut Yankee (PWR) power plant. Thus, the health physicist must endeavour to meet the power needs of the future with nuclear rather than fossil fuel not only in order to reduce chemical pollution but to reduce radiation pollution. At the same time, he must use his influence for the selection of the safest possible nuclear power plants and have them located at sites where there will be a minimum risk to persons living in the environment. Although he may reduce these risks to an extremely low value, he must establish emergency procedures such that in the rare event of a major nuclear accident, he will be prepared to minimize the consequences. In this case, rapid methods of measuring radioactivity in the environment, the subject of this symposium, become exceedingly important.

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Final copy of paper by K.Z. Morgan, in which portions considered unfavorable to the LMFBR were removed by ORNL management.

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HEALTH PHYSICS AND THE ENVIRONMENT*

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Abstract

HEALTH PHYSICS AND THE ENVIRONMENT.

Health physics is the science and profession for the protection of man and his environment from the harmful effects of all forms of electromagnetic radiation while at the same time maximizing its beneficial applications. In the early period (1942-49), there were no recommended national or international levels for the disposal of radioactive waste to the environment, and the health physicist was forced to set his own standards. Although these standards were considered by some at the time as conservative by a factor of 1000, they were larger by factors of 200 to 7000 than those commonly used today. Some early methods for disposal of radioactive waste at Oak Ridge National Laboratory and the more recently developed methods for disposal in hydrofractured formations and in bedded salt are discussed. Environmental sampling techniques used by the early health physicists are reviewed, and the role of the health physicist in determining the critical radionuclides, the critical radionuclides, the critical environmental pathways and the critical segment of the population is emphasized. The health physicist is cautioned not to neglect the principal source of population exposure to man-made radiation, namely, medical diagnostic exposure. Some early objections to radiation ecology research are recalled, and several interesting findings of the Oak Ridge National Laboratory Radiation Ecology Program are indicated. It is emphasized that the health physicist has a major responsibility in identifying the critical segment of a population which receives the highest environmental radiation exposure, and if this is done properly, a bonus reward in terms of improved public relations can be expected by the nuclear energy industry. It is concluded that the present radiation protection standards are reasonable and satisfactory, but they do not contain an unnecessarily large margin of safety. It is urged that the population dose limits should include exposure from medical diagnosis and must continue to maintain a large reserve which, it is hoped, will never be used.

INTRODUCTION

In speaking on the subject assigned to me for this lecture — health physics and the environment — I am sure it will not be necessary for me to give a detailed description of the science and profession of health physics. One may state simply that health physics research is the study of the effects of electromagnetic radiation on matter with particular emphasis on understanding its effects on man and his environment, and applied health physics is directed towards numerous activities designed to reduce radiation exposure of man to the lowest practicable level. Usually, health physicists limit their research and applied activities to problems of ionizing radiation. However, a few health physicists are becoming increasingly involved with non-ionizing radiation — microwave, r.f., laser (coherent), u.v. and thermal problems. All of us are concerned not only with protecting man and his environment from direct and indirect forms of radiation damage but with enhancing the beneficial uses of this great source of energy or maximizing the ratio of its benefits to its risks. The environment with which we are concerned and attempting to protect includes all outside conditions and forces having an effect on the existence and development of man. We hear many discussions today about the pollution of our environment by many substances and by various forms of energy, and we are told this pollution threatens the very survival of many forms of life, including man. Thus, it is of extreme importance, and perhaps there is some urgency that major efforts be made to reduce these energy pollutants which may be classified [1] broadly as:

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(1) chemical — oxides of sulphur, oxides of nitrogen, hydrocarbons, particulates, insecticides, herbicides, detergents, food additives, cosmetics, tobacco, drugs, etc.
(2) mechanical — vibrating buildings, sound, ultrasound and infrasound.
(3) biological — an imbalance of the ecosystem comprised of plants, animals, insects, bacteria, fungi, viruses, etc.
(4) radiation — heat, light, u.v., X-rays, gamma rays, alpha and beta particles, neutrons, high energy radiation, etc.

It should be emphasized throughout these discussions that all forms of energy are valuable human resources which are essential to a better way of life. Also, we should keep in mind that they are not inexhaustible, and they become pollutants of our environment only when man allows too much of them at the wrong place and at the wrong time, or when they are wasted or are no longer under proper control and when they are dumped into our environment with insufficient long-range planning and sometimes with wanton disregard of their ultimate fate or the consequences of their uncontrolled release. I will limit this discussion of health physics and the environment to a brief summary of activities of the health physicist in minimizing and assessing the risks to man from environmental sources of ionizing radiation, and will not mention further sources of non-ionizing radiation such as microwave ovens which in some cases may be introducing serious radiation hazards into our homes. I will further limit this discussion primarily to sources of ionizing radiation associated with the operation of nuclear reactors and their related facilities. However, with this restriction, we will not lose sight of the fact that in many of the advanced countries (and especially in the United States of America), medical diagnostic X-ray exposure accounts for most of the population dose to man-made sources of ionizing radiation (about 95% in the United States of America), and it is here that the health physicist could and should be most effective in reducing unnecessary population exposure. During the past few years, I have indicated in publications [2] and hearings of the US Congress [3] over 100 ways in which this medical diagnostic exposure could be reduced to less than 10% of its present value while at the same time greatly increasing the quantity and quality of medical information provided by the X-ray radiogram. Unfortunately, I have been engaged in a losing endeavour because present estimates are that the genetically significant dose, GSD, in the United States of America from medical exposure in 1970 had risen from the 1964 value [4] of 55 mrem/yr to 95 mrem/yr [5] and the significant organ doses are more than twice these values. I certainly agree it is of the greatest importance to have international symposia such as these directed toward further reducing radiation exposure of populations from nuclear reactor operations, and we must continue to put forth a tremendous effort in order to maintain this new industry as the safest of all modern industries. However, I believe, at least in the

TABLE I. CHANGES IN RADIATION PROTECTION STANDARDS FOR THE RADIATION WORKER

Recommended rate[a]	Comments
0.2 R/day (or 1 R/week)[b]	Recommended as a tolerance exposure by ICRP [7] in 1934 and continued in world-wide use until 1950
0.1 R/day (or 0.5 R/week)[b]	Recommended as a tolerance exposure by NCRP [6] on 17 Mar.1934, and continued in use in the United States of America until 1949
15 rem/yr (0.3 rem/week)	Recommended as a maximum permissible dose by NCRP [8] on 7 Mar.1949, and ICRP [9] in July 1950, and continued in use until 1956
5 rem/yr (0.1 rem/week)	Recommended as a maximum permissible dose by ICRP [10], April 1956, and NCRP [11] on 8 Jan.1957

[a] The values are in addition to medical and background exposure.

[b] Based on a five-day work week.

United States of America, health physicists must not ignore the major population exposure problem, namely, medical diagnostic exposure which is contributing over 200 times as much GSD as the entire nuclear energy industry. In this case, I am including under the nuclear energy industry not only the occupational and non-occupational (environmental) dose from nuclear power plants, but also that from uranium mining, fuel processing and reprocessing, radioactive waste disposal and exposures in the various laboratories that are doing research on reactors and associated facilities.

EARLY HEALTH PHYSICS RULES FOR DISPOSAL OF RADIOACTIVE WASTE IN THE ENVIRONMENT

When health physics had its beginning at the University of Chicago in 1942 and 1943, and when plans were being made for the first nuclear reactors at Oak Ridge, Tennessee, and Hanford, Washington, there were no rules or recommendations that could be referred to as guides in establishing safe and reasonable levels for radiation exposure of the public or for the discharge of radionuclides into the environment. At Oak Ridge National Laboratory (then Clinton Laboratories), H.M. Parker and I were the first to face this problem when ORNL began the discharge of low levels of radioactive waste into the environment (the Oak Ridge Graphite Reactor began operation on 4 Nov. 1943). The only guide we had was the occupational tolerance dose rate of 0.1 R/d which, as indicated in Table I, had been recommended by the National Council on Radiation Protection, NCRP, in 1934 [6]. The radioactive liquid waste containing high concentrations of radioactivity and the solutions comprising the dissolved fuel elements were retained in underground storage tanks. Intermediate and low levels of liquid, radioactive wastes were discharged into open settling ponds which emptied into White Oak Lake. White Oak Lake is an impoundment of five to seven million cubic feet of water located in the Oak Ridge reservation at a distance of about one mile from Oak Ridge National Laboratory. The outflow of White Oak Lake runs into and mixes with the waters of the Clinch River about one-fourth of a mile below the overflow at White Oak Lake dam. It is at this point that the contaminated waters mix with and are diluted by those of the public domain. Lacking any suitable guidance from NCRP or the International Commission on Radiological Protection (ICRP), Parker and I chose as our radiation protection standard a dose limit of 0.1 R/d to an imaginary microscopic organism suspended in the waters of White Oak Lake. We determined this dose theoretically and experimentally by dissolving various radionuclides in large tanks of water and making measurements of the dose received by a small dosimeter. We established this same standard, also, for airborne radioactive contamination which might result under expected meteorological conditions following the escape of radioactive gases or particulates from tall laboratory stacks. These stacks were used for venting, dispersing and diluting chemical off-gases and cooling air from the reactor and associated laboratory facilities, the "hot cells" and chemical, physical and metallurgical operations after the air had been passed through appropriate filter and precipitator systems. When some of the engineers, public health officials and "behind-the-desk supervisors" heard of the dose limit we had set which was based on an exposure rate of 0.1 R/d for exposure 24 h/d, we were severely criticized and ridiculed for such ultraconservatism. Although this early limit for environmental exposure is high in comparison with present standards, in retrospect it probably was not so reckless when we consider the waste water from White Oak Lake had an average dilution of greater than 600 just below the point of mixing in the Clinch River where it enters the public domain. Since ORNL is about 10 miles from the nearest populated area (the village of Oak Ridge), the dose rate from ORNL gaseous effluents never reaches 10% of this level. On the other hand, this 0.1 R/d level was over 200 times the 170 mrem/yr population dose limit permitted in the United States today for such an operation and over 70 times the 500 mrem/yr value recommended by ICRP as an upper limit of dose to any individual in the population-at-large. Furthermore, at that time we had very scanty information regarding the body uptake of radionuclides from inhalation of air or ingestion of water contaminated with radionuclides, or from ingestion of food contaminated as a result of cycling of radionuclides in the environment. We believed in 1943 that ^{239}Pu and ^{90}Sr probably presented serious risks from internal exposure, but the data available to assess this risk and to set permissible organ burdens or maximum permissible concentrations in air and water were almost entirely lacking. This early experience where we set health physics tolerance levels at what many persons thought were too low by a factor of 1000 only to find out some 30 years later that they were too high by a factor of 200[1], has had a very sobering influence on some of us, and guided and supported our claim that there may still be pathways and forms of radiation damage to man which are not adequately understood, and so all human exposure to ionizing radiation should be maintained as low as practicable, and no radiation exposure which can be avoided easily should be tolerated.

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[1] The USAEC is considering setting the dose limit of 5 mrem/yr to individuals living in the neighbourhood of a nuclear power plant as a consequence of nuclear plant operations. The spread between this 5 mrem/yr and the level suggested by some critics in the early period (1943-45) is 7×10^6.

During the first decade of nuclear reactor operations, two contrary and often conflicting philosophies of radioactive waste disposal were developed and commonly applied: (1) dilute to tolerance levels and release; and (2) concentrate and retain forever. As can be seen from the papers presented at this Symposium, both philosophies are actively employed today although there appears to be a trend toward the more conservative approach of concentrate and retain forever.

TYPICAL EARLY SYSTEMS APPLIED BY HEALTH PHYSICISTS AT ORNL FOR DISPOSAL OF RADIOACTIVE WASTE INTO THE ENVIRONMENT

The methods of radioactive waste disposal at ORNL in the early period and in subsequent years have been rather typical of those used by many other large operations that dispose of radioactive waste: retention and release under controlled conditions. The history and experience of health physics operations as they relate to radioactive waste disposal in the environment at other sites such as Hanford, Brookhaven, Savannah River, Windscale, Harwell, Karlsruhe, etc., recall many lessons worthy of review, but because of limited time and limitations of my personal experience, I will restrict this discussion primarily to health physics and its control of radiation in the environment of ORNL.

The volume of flow of contaminated water from ORNL into the settling ponds soon after 1943 became so large that these ponds were renamed retention basins because the residence time was too short for appreciable settling to take place. Automatic sampling devices were placed at the outflow of the retention basins and White Oak Lake as well as in the stacks that discharged low levels of airborne radioactive contamination into the environment. During the 28 years of operation of our Laboratory, there have been only a few minor incidents in which relatively high levels of radioactivity were introduced into the environment. These incidents include the release of fairly large "slugs" of radioactivity into White Oak Lake occasioned by errors in procedure, malfunctions of apparatus, and by unusual releases of contamination from the seepage pits, tanks and associated transfer pipes. On a few occasions caused by fires, breakdown of precipitators, breakthrough of filters and the rupture of slugs, there were releases of high levels of airborne contamination (e.g. activated uranium oxide particles, ^{131}I, etc.), but on all such occasions, the environmental monitoring systems gave early warning, and our analytical procedures provided a basis on which to judge the magnitude of the risk. Papers in this Symposium discuss rapid methods for measuring radioactivity in the environment. Certainly, the early availability of sampling data and a rapid interpretation of health physics analytical results will add greatly to the safety of reactors and associated operations.

As more information became available and when recommendations for maximum permissible concentration in the air and water were provided by NCRP and ICRP, this information was used in updating the health physics radiation protection standards. Likewise, limits were set on the maximum number of curies which could be discharged per day into the air and into White Oak Lake. As time went on, our Laboratory grew in size and complexity. Up to now, there has been a total of nine reactors in operation in our area at one time or another, plus a continuous series of critical assemblies in the criticality test facility. In addition, there have been numerous physical, chemical, engineering and metallurgical operations, all of which have contributed their share to the ORNL radioactive waste. Also, there has been in use a number of areas for the temporary storage of solid, radioactively contaminated equipment ranging in size from bolts and nuts to trucks and bulldozers. Some of this equipment was decontaminated and returned to use, but in recent years more and more of the equipment contaminated with long-lived radionuclides has been taken directly to the burial grounds for permanent disposal since often the cost of decontamination exceeds the value of the equipment, and it is virtually impossible to decontaminate satisfactorily certain equipment, e.g. pipes contaminated with ^{239}Pu. In the history of our Laboratory, there have been six separate burial grounds in use for the disposal of ORNL radioactive solid waste. All these grounds have been located in restricted areas within one mile of the centre of the Laboratory, and they have been located in Conasauga shale formations which were purposely selected by our geologists to provide very little seepage and slow leakage and drainage of the radioactive contamination into White Oak Lake where the level of radioactivity of the water is carefully monitored on a continuing basis. During the past two decades, ORNL has interred, also, in its burial grounds radioactively contaminated waste from a number of operations outside Oak Ridge. The total number of curies actually buried in our burial facilities is not known but has been estimated at approximately 10^6 Ci. Our burial grounds to date have used or placed in permanent restriction 68 acres of land, and at present we are consuming in this manner 0.8 acres per year. In the early period, some of the solid waste was reduced in volume by incineration, but radioactive waste was never burned because of the cost and the expected difficulty of maintaining acceptable levels of air contamination in the vicinity of the Laboratory.

As ORNL grew from its early 1000 employees to its present population of 5000 and as the number of sources and volume of radioactive waste increased by orders of magnitude, it became apparent that some means must be provided to reduce the amount of intermediate- and high-level liquid waste stored in underground tanks and that we must develop some process for treating intermediate- and low-level waste solutions. Such steps became necessary not only to reduce the potential risk of large quantities of long-lived radioactive waste stored in underground tanks at the centre of the Laboratory but to meet the more conservative environmental radiation protection standards. Also, the cost of building additional underground tanks and monitoring their safe use into perpetuity was a considerable item of expense. One interesting health physics experiment during this early period was the use of open pit and rock-filled seepage trenches for the disposal of intermediate-level (several μCi/ml) radioactive waste. Studies of open pit operations provided much valuable information regarding retention and mechanisms of movement of various radioactive materials through the minerals in the soil. Seepage pit disposal was discontinued at ORNL, however, in 1966 because of the rapid leakage of the ruthenates and because a new concept of waste management, hydraulic fracturing, was proved to be a more successful method for disposal of these wastes.

ORNL HEALTH-PHYSICS RADIOACTIVE WASTE DISPOSAL RESEARCH

Time will not permit a review of all the early health physics radioactive waste disposal research studies such as self-sintering of radioactive waste, liquid waste disposal in salt formations, evaporation techniques and modifications of conventional lime-soda-ash waste treatment methods to accommodate them to the removal of low levels of radioactive material, so I will mention only briefly the results of two of our health physics studies which, during the past 20 years, have been productive and appear to be promising as means of removing and permanently isolating radioactive waste from our environment. Also, we believe these methods can be applied in many other suitable locations throughout the world. I refer to our studies on hydrofracturing and solid waste disposal in bedded salt formations.

As mentioned above, some of the ORNL area is underlaid by a rather impermeable layer of soft rock or clay called Conasauga shale. After an extensive series of studies, we have developed the technique [12] by which a 5½-in. well casing is drilled to a depth of about 1000 feet in this Conasauga shale. Then the well is cased and plugged at the bottom. A slit is sandblasted in the casing a few feet from the bottom and water is pumped into the well under pressure at about 2500 lb/in.^{2}. This fractures the shale in the formations more or less in a horizontal plane. Then a mixture of clay, fly ash, cement, intermediate-level radioactive waste and chemical compounds to control the rate of solidification (mostly sugar) is pumped under pressure into the fracture in the shale. Typically, it spreads out in a thin, pancake shape several millimetres in thickness to a radius distance of about 150 m. Shortly thereafter, the cement mixture sets into a hard formation which will be isolated from man's environment for thousands of years. About six months later, another slot (perhaps 10 ft above the previous one) is cut in the well casing, and the hydrofracturing procedure is repeated. Each batch of disposed radioactive waste consists of about 80 000 gal and commonly contains about 40 000 Ci, much of which is ^{90}Sr and ^{137}Cs with small quantities of transuranium radionuclides (e.g. 0.2 mg/gal of ^{239}Pu). This method of isolating radioactive waste from the environment can be used only where there is a suitable, relatively impermeable geological formation which can be hydrofractured in more or less a horizontal direction. It should not be used except where adequate confirming test wells have been drilled. Although we have limited the hydrofracturing technique to the disposal of intermediate level waste (e.g. concentrate from the waste evaporator), it is a method which I believe could be extended safely in the Oak Ridge area to the disposal of high-level radioactive waste (all health physicists do not agree on this point) in Conasauga shale and other suitable impermeable formations. This extension perhaps would be more acceptable if the formations selected were below sea level. The thin "pancakes" of solid waste are ideal for disposing of the heat that would be generated from high-level radioactive waste. By hydrofracturing to the present time (1971), ORNL has disposed of about 600 000 gal of concentrated, intermediate level, liquid radioactive waste containing about 400 000 Ci.

After many years of health physics research [13] on the disposal of solid radioactive waste in bedded salt formations in Kansas, this method has been proposed for ultimate waste disposal because it appears to be safe and practical. The USAEC has requested authorization of a national demonstration waste repository near Lyons, Kansas. Our health physics studies have indicated the safety of this method of disposal by confirming the integrity of the salt, the low chlorine formation, the slow deformation of the salt columns in the mine when under added stress of temperature and radiation, and the ability of the salt formations to dissipate adequately the heat from the radioisotopes and from the stored energy (Wigner energy) in the salt structures. The operation of this facility will consist of excavating rooms in the salt formations and burying containers of solid radioactive waste in holes that have been drilled in the floors of these rooms. Remote control equipment and specially designed vehicles are used in these operations to reduce exposure of the mine operators to negligible levels. After a room floor has been filled with radioactive sources, it will be backfilled with loose salt. In a matter of a few decades, the loose salt in the backfilled rooms will be compressed and annealed into a solid mass again, thus encasing and sealing the radioactive material in a self-sealing formation where it will be isolated safely from the environment for thousands of years while it decays to stable isotopes. We are confident of this course of events because the salt could not have been here in the first place unless during the past millions of years it has been isolated from large volumes of water. This project is currently being considered in the US Congress. If it is authorized for fiscal year 1972, acquisition of the site and detailed design will commence about Oct. 1971. Construction will begin in the spring of 1973 after all safety reviews have been completed. If the schedule at present envisaged holds, and if no unexpected findings change our present view that the salt will adequately contain solid wastes, limited disposal operations will begin in 1976 and will continue to the end of the century. During this period, the facility will handle and store solidified, high-level fission product wastes from the US nuclear power industry plus about 20 million cubic feet of packaged solid wastes contaminated with long-lived transuranium isotopes generated primarily at AEC installations. In the meantime, a more limited use of salt for the disposal of radioactive materials has been adopted and is currently being practiced for the isolation of low-level solid wastes in the Asse II mine near Hanover, Federal Republic of Germany.

ENVIRONMENTAL SAMPLING TECHNIQUES USED IN EARLY HEALTH PHYSICS PROGRAMS

I am sure it is clearly understood without repeating at this Symposium on Rapid Methods for Measurement of Radioactivity in the Environment that the best way of handling situations requiring rapid measurements in emergencies is to apply the first health physics principle: namely, use appropriately designed equipment kept in proper maintenance and use well-thought-out procedures by adequately trained personnel to avoid emergencies and accidents of all types; it is much easier, less costly and better for public relations to avoid accidents than to provide adequately for them after they have occurred. Some accidents lead to a loss of property, which at times is difficult if not impossible to replace, and even to loss of life. However, we must never forget that because of imperfections in machinery and fallibilities of man, if an accident can happen, it eventually will happen. The health physicist must be prepared in advance to handle such an accident swiftly and adequately. One of the best ways of implementing the capability for handling emergencies is to build into existing health physics environmental sampling programs systems and techniques which can be adapted to rapid analysis. In this Symposium, new equipment and techniques for rapid analyses are discussed by others, so I will limit this part of my discussion to mentioning a few of the early instruments and environmental sampling techniques so that we can appreciate better from the papers that follow how old equipment and well-tried techniques can be and have been modified and augmented to provide the required speed of sample analyses during the time of an emergency.

If there is a serious accident in a reactor or chemical facility, it is likely to be apparent immediately that there is an emergency requiring rapid environmental sampling, but, unfortunately, one cannot always be sure by what means it will become apparent first that there is a radiation emergency requiring information from rapid sample analysis. No one system of data collection and sample analysis is adequate, and usually input from many sources of information is required as an acceptable basis of confidence in the results and their interpretation. Health physics surveyors in various areas of an operation are frequently the first to sound the alarm of an impending environmental contamination emergency. Sometimes it is the output information received at the central instrument panel of the facility that sounds the first warning of high activity or a rapidly rising activity in an exhaust stack, holding pond or downwind in the neighbourhood of a health physics monitoring station. Frequently, many of our area monitoring, perimeter monitoring and outlying monitoring stations provide early readings which caution the need for certain modifications in plant operations or indicate a developing inefficiency in a filter system, thus giving warning of impending events or accidents which are avoided by immediate remedial action on the part of the health physicist and co-operating plant employees. Such warnings may come from indirect evidence such as the buildup of a radionuclide in river mud, the increase in levels of radioactivity in fish or crustaceans in the river or the radioactivity in birds that may be using the settling ponds for a halt during their migration. Sometimes there are sharp rises in the number of radioactive particles on the collection trays, gum paper collectors and filter paper of the air samplers. From a proper distribution of such samplers about the perimeter of an operation, it is easy very quickly to differentiate between the rises in activity due to plant operations and those due to weapons testing in some remote part of the world. Regardless of the source of information which suggests the development of an environmental contamination problem, the methods of rapid sample analysis discussed in this Symposium should be well developed and on a standby operational basis ready to be placed in operation immediately in providing quantitative analytical information at the earliest possible moment. One extremely useful method of early rapid location of areas of radioactivity and of giving some information of the magnitude of the contaminant in various parts of the environment and surrounding communities is that of aerial surveys. Some of the earliest work in the development of airborne radiation monitoring equipment was done (1949) by Davis and Reinhardt of our Health Physics Division [14]. These instruments were developed for sampling the air as well as measuring the radiation shine from the ground. In more recent years, these instruments have been improved and developed such that they have extreme sensitivity and reliability for locating weak sources on the ground and identifying the radionuclide involved. As would be expected, most such equipment can be conveyed equally well by truck or boat, thus bringing the sampling and measuring devices to the samples in situ in time of emergency and providing very rapid feedout of information to those who must make decisions which may involve evacuation, restrictions in the use of certain food and water supplies, etc. Such equipment must be ready to operate reliably on a moment's notice if it is to serve its most useful function in time of emergency, i.e. to evaluate the seriousness of environmental contamination.

During the past 20 years, all major reactor laboratories in the world have been developing and implementing the use of various types of nuclear accident dosimeters. Although the detectors used in the various systems are quite different and serve other functions from those designed to assess radioactivity in the environment, the auxiliary counting equipment and other laboratory facilities used in processing nuclear accident dosimeters and evaluating the results are very similar and certainly in some cases they are the same as those used in rapid methods of measuring radioactivity in the environment. Perhaps in some of the papers that follow, this tie-in of equipment and facilities which tends to reduce the cost of preparedness of a laboratory to handle adequately emergencies (both foreseen and unforeseen) will be mentioned. For the past few years, those responsible for nuclear accident dosimetry at the various nuclear facilities in many countries of the world have been meeting under the sponsorship of the International Atomic Energy Agency at our health physics reactor facility and at similar facilities in other countries to compare and calibrate the various emergency dosimeter systems. I believe these comparison and calibration studies have been most useful because each year these programs are conducted we find less deviation in instrument results and more reliable and rapid feedout of information following exposure of the nuclear accident dosimeters to various types and combinations of ionizing radiation. Perhaps it would be in order to suggest that it might serve a useful function if there could be similar comparisons and calibrations of rapid methods for measuring radioactivity in the environment.

HEALTH PHYSICS MUST AID IN MINIMIZING RELEASE OF RADIONUCLIDES TO THE ENVIRONMENT

ICRP [15] in its publications had indicated that it would be virtually impossible for a health physicist to follow in detail all the approximately 800 radionuclides that could be released from a reactor and its associated operations. Similarly, it indicated the impossibility of following all the food chains in the environment and of studying carefully all the various population groups. Fortunately, it has shown that such comprehensive studies are not necessary in ensuring adequate protection of those living in the environment of these operations. It has provided a simplified procedure that health physicists can follow by which they can judge the adequacy of their environmental monitoring program. It involves three steps: (1) determination of the critical radionuclide(s) that may be released routinely or during accidents involving the reactor or associated facilities; (2) a study of the critical pathways by which these radionuclides may result in appreciable radiation exposure to man; and (3) an evaluation of exposure to the critical segment of the population.

Health physics responsibilities begin long before the construction of a reactor and associated facilities when background measurements are made which are to serve to normalize and compare all future measurements. The senior health physicist should be involved in a major way in the purchase of radiation protection devices and instruments, the establishment of procedures which can be expected to minimize occupational and environmental exposure, and in the preparation of potential accident evaluation reports in which assessments are made of the maximum credible accident and its consequences. I believe all too often it is not recognized soon enough that the senior health physicist can play a major role in developing the proper public attitudes and ensuring in the eyes of the public the acceptability of a nuclear power plant or associated facilities in its community. The health physicist who is encouraged to play a major role in the reactor safety program will develop a list of radionuclides in the order of decreasing priority in terms of the part they would be expected to play in causing exposure to employees and to persons living in the neighbouring environment during routine operations of the reactor and associated facilities and if an accident occurs.

One cannot state with certainty the consequences of low-level exposure of populations from routine operations of reactors or exposure during the unlikely event of a major accident. In assessing the consequences of any radiation exposure, ICRP [16] takes the position that the most prudent assumption is that there is a linear relationship between dose and effect. During the last few years, a large mass of data has been collected in several countries which, although it does not prove a linear relationship between dose and effect, suggests very strongly it is reasonable to assume this relationship. Hempelmann [17] has indicated from his studies of several population groups ranging in thyroid dose from 1200 rad down to 20 rad that (1) the dose response of thyroid tumours is linear in the low dose range, and (2) there is no threshold or at least the threshold is below 20 rad. Stewart and Kneale [18], Brian MacMahon [19] and many others [20] have reported an increased incidence of leukaemia of 30-50% among children whose mothers were exposed to 1 or 2 rad of diagnostic dose during pregnancy. Although studies of Russell [21] have indicated a rate dependence for exposure to mice below dose rates of 5000 R/h, the average drop-off in point mutation frequency at low dose rates for the two sexes is only by a factor of about 1/6, and there is no evidence of any further drop-off in mutation frequency at lower dose rates. In dealing with estimates of risks due to radiation, I have therefore chosen to deal with numbers such as those provided by the ICRP [22, 23] on the assumption of a linear relationship between dose and effect.

When making estimates of the radiation risk to the population from the nuclear energy industry, I think in all fairness we should make comparisons also of the radiation risk to the population from the other more important sources of ionizing radiation exposure. In Table II I have compared the risk from medical diagnosis in the United States of America with that of routine exposure in the nuclear energy industry. In obtaining the figures given in this table, I have used the preliminary estimates from the 1970 survey of the US Public Health Service [5] of the genetically significant dose to the United States population from medical diagnosis. In the case of somatic exposure, I have used the data from the 1964 survey of the US Public Health Service. Since the GSD from medical exposure went up from 55 mrem/yr [4] in 1964 to an estimated 95 mrem/yr in 1970, I probably have underestimated the risk of somatic damage from medical diagnosis by a factor of 2. The larger figure of genetic deaths per year (76 000) from medical diagnosis is the number of genetic deaths introduced into the population per year from the GSD of 95 mrem/yr. Most of these deaths would make their appearance in future generations. By comparison, it is assumed the present dose to the

TABLE II. COMPARISON OF CONSEQUENCES OF X-RAY DIAGNOSTIC EXPOSURE AT PRESENT RECEIVED BY THE US POPULATION WITH THE CONSEQUENCES OF A CONTINUOUS EXPOSURE FROM ALL NUCLEAR INDUSTRIES OF 0.5% OF THE ALLOWED 170 mrem/yr (0.85 mrem/yr)

Types of radiation damage	Consequences of medical X-ray diagnostic exposure at present received by US population (deaths/yr)	Consequences of hypothetical exposure of 0.85 mrem/yr to US population from nuclear industries (deaths/yr)
Genetic	1900[a] to 76 000[b]	3[a] to 120[b]
Leukaemia	500	3
Thyroid cancer		
(a) from dental X-rays	16[c] to (160)	0.2[c] to (2)
(b) from thorax X-rays	2[c] to (20)	
Other cancer	500	3
Life shortening	1200	8.5
Total deaths (~)	4100 to 78000	18 to 140

[a] This includes only first generation genetic deaths and assumes the factor of 1/6 does not apply to the high dose rates ordinarily used in medical X-ray diagnosis but does apply at the very low dose rate of 0.85 mrem which would be delivered during the year.

[b] This includes genetic deaths in 40 subsequent generations and assumes the genetic recovery factor of 1/6 does not apply in the case of man for medical diagnostic exposure but does apply at the very low dose rate of 0.85 mrem/yr.

[c] This is assuming 90% of thyroid cancers are cured by medical treatment and so are not included in this number. The numbers in parentheses include all thyroid cancers.

US population from all the nuclear energy industries is less than 0.5% of the 170 mrem/yr suggested by ICRP [16] as an average GSD to a population. On this basis and according to the linear hypothesis, there would be in the United States of America 18 deaths/yr and 140 deaths introduced into the population/yr. These numbers are the deaths that would be expected on the linear hypothesis as a consequence of both occupational and environmental exposure (non-occupational exposure) from the entire nuclear energy industry (i.e. from operations in all the national laboratories doing reactor research, all exposure from the nuclear power plants, and from the plants fabricating and reprocessing reactor fuel elements and from the radioactive waste disposal operations). In this case, deaths from somatic damage resulting from exposure of workers in the uranium mines of the Colorado Plateau are excluded from Table II but included in the deaths from high exposure rate in Table III.

HEALTH PHYSICS AND RADIATION ECOLOGY

The previous section dealt primarily with problems relating to critical radionuclides, and this section deals with the problem of critical pathways and the fate of these radionuclides once they are released into the environment. When E.G. Struxness, Orlando Park and I almost 20 years ago

TABLE III. DEATHS/YR IN THE UNITED STATES OF AMERICA FROM ALL SOURCES OF EXPOSURE TO IONIZING RADIATION (ESTIMATES BASED ON ICRP LINEAR HYPOTHESIS)

	Deaths/yr	Deaths introduced/yr to population
	Low exposure rate	
Natural background	5000	(20 000)
Weapons fall-out	30	(160)
Nuclear industry (routine operations)	20	(140)
All other exposure	10	(70)
	High exposure rate	
Medical (diagnostic)[a]	4000	(80 000)
Medical (therapeutic)[a]	800	(8000)
Uranium miner lung carcinoma[b]	10	
Radiation criticality accidents[a]	0.3	
Total	10 000	(110 000)

[a] Average dose rate assumed to be sufficiently high that the factor of 1/6 does not apply.
[b] Average dose rate assumed to be sufficiently low that the factor of 1/6 applies.

established the first radiation ecology research program of the AEC at Oak Ridge National Laboratory, we ran into opposition. This was at a time when few people knew the meaning of the word "ecology" and before many persons recognized the necessity of obtaining more information on the critical pathways of these radionuclides in various food webs, and especially the pathways leading to man. The first criticism of our early proposal for a radiation ecology program was, "Why should we be concerned about these ecosystems? Certainly man was the most important element of concern in the environment. So long as we protected him, we need not be concerned with the effects of radiation on other organisms." The fallacy of such an argument is so obvious today that it needs no comment. All of us are acutely aware that man can be eliminated from the ecosystem indirectly and perhaps just as easily as by the direct effects of environmental insults such as excessive ionizing radiation. Another criticism was, "It takes 10^5 or more rems to destroy bacteria and fungi, so why should we be concerned when it takes only about 600 rem to destroy man? So long as man is not harmed, we need not worry about these other elements of the environment." Since that time, of course, it has been learned that it takes relatively low doses to eliminate many microorganisms in the environment. In some cases, it may take large doses to destroy the individual but relatively low doses to prevent its reproduction. Today, we know that even some plants such as the pine tree have a mid-lethal dose about equal that for man. Another response which in retrospect seems difficult to believe was, "Why not just dilute the radionuclides by a factor of 10^6, dump them in the rivers and forget about them?" Our answer then was we thought there might be factors of reconcentration of a hundred or more, and we did not feel this would be a safe procedure. Today, we know that ^{32}P can be concentrated in skeletons of fish, and iodine can be concentrated in milk by factors of 10^4 to 10^5 above those in the environment (i.e. in the water and air respectively), and so rather generous dilution factors might be lost under such environmental circumstances. The response we received to our proposal for a radiation ecology program which seemed just as absurd then as it does today was, "Why worry about destroying bacteria, fungi, arthropods, etc.? It would be a good thing to get rid of them." Fortunately, today, it does not require any great effort to convince those in authority of the need for radiation ecology. In fact, these programs are receiving very strong support by the USAEC and other government agencies. I consider such programs an important part of health physics. Most biological research with mammals is conducted with inbred animals while man is a wild species, and this alone speaks strongly for ecological studies of various forms of life in a wild environment.

In this short discussion, it would be impossible even to list all the interesting highlights of the Oak Ridge National Laboratory radiation ecology program. One study of considerable interest was concerned with a common redworm (Chironomus tentans larvae) [24] which lives in the mud of White Oak Lake. These worms, with an average life cycle of about 30 d, have been exposed at an average dose rate of 230 rad/yr for about 150 generations, and we thought it would be of interest to study the effects of these relatively large doses of radiation on many generations of these organisms. Studies were conducted of the chromosomal aberrations in the salivary glands of these worms, and it was found that this radiation exposure apparently has increased the variety of these aberrations but not the number. The newly occurring aberrations are eliminated by selection or genetic drift and are not maintained in the gene pool of the population. In order to study a comparable population of humans, investigations would have to go back thousands of years before the time of Christ. Perhaps these studies suggest that in a mammalian population radiation would be expected to increase the variety of chromosomal aberrations but that there would be on the average only a certain number of new aberrations plus the endemic ones that could be tolerated in a surviving population. The study of freshwater clams [25] showed striation buildup of strontium in the shells which was very interesting and suggested this biological dosimeter as a mechanism for estimating the past history of a stream in terms of its burden of ^{90}Sr. We never learned why the pipe-organ mud-dauber wasps [26] seem to prefer to build their nests of radioactive mud from White Oak Lake while the black-and-yellow mud-dauber wasps seem carefully to avoid this radioactive mud. Neither was it understood why 10 000 rad of ^{60}Co gamma radiation reduces the mean life of caged honey bees [27] in laboratory experiments by less than 50%, but it requires only 5000 rad to completely destroy a bee hive consisting of a highly organized social environment such as that in which man lives. I do not wish to leave the impression that radiation ecology only raises questions and does not answer them; quite the contrary, it has provided extremely valuable guidance in many problems relating to radioelements in the environment. As can be expected in an active research program, however, it has raised many important questions which have not yet been answered but perhaps would never have been asked until too late unless such programs were in existence. Once it is known which are the more important radionuclides likely to be released into the environment, radiation ecology studies in the laboratory and in the field are the only satisfactory means by which one can be assured that the critical pathways leading to man will not concentrate them in such a manner as to seriously damage man's environment including his food web and man himself.

HEALTH PHYSICS HAS A MAJOR ROLE IN IDENTIFYING CRITICAL SEGMENTS OF THE POPULATION

As indicated above, the third requirement of ICRP for an adequate radiation environmental program associated with a nuclear power operation is that of identifying the critical segment of the population. This, I believe, is the most important of the three parts of the problem as defined by ICRP, but in some respects it is the most difficult. The critical segment of the population may be a certain age group; it may be the in uterally exposed individuals or it may be persons with certain diseases. The critical population may be individuals in whom the critical body organ is small, and yet such individuals have the same uptake of the radionuclide as the average individual leading to higher concentrations in this organ. A case in point is ^{131}I which concentrates in the thyroid of the young child which is about 10% the mass of the adult thyroid. In addition, the child may drink more ^{131}I-bearing milk and have a higher thyroid radiosensitivity than the adult. The critical segment of the population may be a group of people who have certain customs or religious habits that cause them to eat certain food with high concentrations of one or more of the radionuclides. Some Welsh people, for example, eat seaweed contaminated with radionuclides discharged from the Windscale operation into the Irish Sea. If a radionuclide adds appreciably to the genetic dose, the critical segment of the population obviously consists of the persons of childbearing age. The weight and sex of an individual can be important factors determining the uptake, distribution and radiosensitivity of an individual. Much of the information needed in identifying the critical segment of a given population may be missing, and this means certain experimental data must be collected from the population which is to be exposed. The internal dose handbook of ICRP [28] contains useful data on the uptake, distribution and elimination of radionuclides in the human body but almost no data on the variation of these parameters with age, sex and eating habits of the population. ICRP has under preparation a "Reference Man Report" (Snyder, chairman), and this should provide a wealth of data for making some of the calculations necessary in identifying critical members of the population. One of the finest programs which has been conducted leading towards the identification of the critical segments of the population was that by Honstead at Hanford [29]. I would urge health physicists to read the reports describing this program and make similar measurements in their locality to enable them to estimate the dose received by individuals in the environment of reactor operations. At Hanford, a mobile shadow-shield instrument mounted in the back of a van truck was used to measure the body burdens of plant employees, school children, persons selected at random from the population and fishermen with diets that might be expected to lead to unusually large internal doses from the accumulation of radionuclides discharged by the Hanford plants into the Columbia River. This study showed not only which persons are likely to be the critical segments of the population but provided information on the critical pathways of radionuclides to these populations. For example, studies indicated the significance of eating fish, eggs, chickens, wild game, milk and leafy fresh vegetables that would be expected to accumulate relatively large concentrations of certain radionuclides from the Hanford environment. A very valuable and perhaps unexpected dividend of the Hanford program was the great improvement in public relations. Through this program, the population in the environment of Hanford was able to participate in the health physics evaluation of the radiation problem and was given a better basis on which to judge the relative risk of radioactive contaminants in the environment. They learned that the dose they received from the Hanford operations was only a part of that from fall-out from testing of nuclear weapons and a small fraction of that from medical diagnosis.

Finally, I would like to point out that ICRP has set the population dose limit primarily in terms of 500 mrem/yr to the individual and an average of 170 mrem/yr to a given population. In setting these radiation protection standards some years ago [16, 30], ICRP gave special consideration to the genetic risk or the genetically significant dose. More recent evidence, however, indicates that the genetic risk is somewhat less and the somatic risk somewhat greater than we thought earlier. The relatively increased concern for somatic damage derives from the fact that Russell's [21] experiments in mice indicate the mutation frequency decreases by a factor of 1/6 at low dose rates. Also, the high incidence of malignancies among children diagnostically exposed to 1 to 3 rem in utero suggests that a dose to the individual of 500 mrem/yr may not offer much margin of safety.

In conclusion, I believe the present radiation protection standards are reasonable and satisfactory in spite of the fact that they may not contain a large factor of safety. I must be quick to state, however, that I believe they are acceptable only so long as we continue our present practice of maintaining occupational exposures and exposures of members of the population-at-large far below the recommended dose limits. As indicated above, the average dose received at present by the population in the United States of America from nuclear power operations is less than 1 mrem/yr in comparison with an estimated genetically significant medical dose of 95 mrem/yr and a significant organ dose of about 200 mrem/yr from medical diagnosis. I believe it is of the utmost importance in our country that medical diagnostic exposure of the population be included as part of the 170 mrem/yr allowed to the average member of the population. I believe it would be extremely helpful if an appropriate authority in each of the major countries would pro rate this 170 mrem/yr and 500 mrem/yr to the various sources of population exposure.[2] In so doing, I would urge that a large fraction of the 170 mrem/yr (and at least 50 mrem/yr) be set aside as a reserve for future unexpected applications. It would seem to me a reasonable goal would be to assign this 170 mrem/yr as follows: 5 mrem/yr for diagnosis; 10 mrem/yr for therapy; 10 mrem/yr from the nuclear energy industry; 5 mrem/yr from other environmental exposure; and 10 mrem/yr from occupational exposure including that in the nuclear energy industry; the rest, 130 mrem/yr, could be assigned to reserve. Perhaps it will be towards the end of the century before such a goal can be attained in our country but not so in other countries.

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[2] The USAEC is considering setting some fraction of this 500 mrem/yr (perhaps 5 mrem/yr) as the dose limit to individual members of the population living in the neighbourhood of a nuclear power plant as a consequence of operations of the plant.

For example, the genetically significant dose in the United Kingdom in 1957 was estimated to be only 14 mrem/yr, and Adrian [31] has indicated that it could be reduced to 2 mrem/yr if all the radiological departments employed the techniques already in use in 25% of the departments employing better techniques and facilities.

I foresee in the years ahead that health physicists will play an even more important role in minimizing energy pollution of the environment. By convincing the public that nuclear power plants are far safer than fossil fuel plants, and encouraging their substitution for fossil-fuelled plants, they can almost eliminate one of the major and more harmful sources of pollution, oxides of sulphur. Very importantly, they can at the same time reduce radioactive contamination of the environment. For example, studies of Martin, Howard and Oakley [32] have shown that the radiation dose per megawatt of electricity from the radioactive daughter products of uranium and thorium to persons living in the neighbourhood of a modern, coal-fired plant can be 10 to 100 times that to persons living in the neighbourhood of a pressurized water reactor such as the Connecticut Yankee (PWR) power plant. Thus, the health physicist must endeavour to meet the power needs of the future with nuclear rather than fossil fuel not only to reduce chemical pollution but to reduce radiation pollution. At the same time, he must use his influence for the selection of the safest possible nuclear power plants and have them located at sites where there will be a minimum risk to persons living in the environment. Although he may reduce these risks to an extremely low value, he must establish emergency procedures such that in the rare event of a major nuclear accident he will be prepared to minimize the consequences. In this case, rapid methods of measuring radioactivity in the environment, the subject of this Symposium, become exceedingly important.

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Mr. ROGERS. Would the gentleman permit me one question? Isn't it an unacceptable scientific procedure for someone else to change the results of a scientist's paper? Is that generally accepted in the scientific community?

Dr. MORGAN. No. I would say that is very irregular for the scientific community.

Mr. ROGERS. Thank you.

Mr. OTTINGER. Dr. Sperling?

Dr. SPERLING. My history of involvement is much shorter. Let me divide my answer into two parts, the first part dealing with people and agencies, the second part dealing with regulation and law.

When I started trying to compile information on Smoky, one of the first agencies I called was the Defense Nuclear Agency. I had my secretary make the initial call requesting information on Smoky. I don't know the name of the person she spoke with, but he told her that DNA would contact me within a few hours. Instead, they contacted the president of our company. My secretary was informed by his secretary that DNA wanted to know what I was doing. I can't remember whether I had a call from the president himself that day, but I did have a call from him 2 or 3 weeks later. He questioned me in detail on my activities in connection with Smoky. I have a lot of respect for the president of our company, and I feel his attitude at that time was one of factfinding. But I also think it was a response motivated by the DNA phone call.

Mr. OTTINGER. Was the company the same company you are with now?

Dr. SPERLING. Yes, Science Applications. We depend to a large degree on contracts from agencies in the Defense Department. I think DNA is one of our oldest customers.

I filled him in on what I had done to that point. He then asked if what I was doing could hurt either the Defense Department or DNA, I can't remember which. I said the radiation exposure levels might have been higher than indicated by the film badges. He then switched the topic of conversation to what seemed like small talk, what was I doing, et cetera. But in retrospect I think he was trying to determine if I was being supported by Defense Department funds. It happened that I was not.

One of the other sources I used quite extensively was professionl colleagues. We have a number of people in our company who have been involved with nuclear devices and weapon test data, perhaps or perhaps not going back to Smoky in particular, but certainly of the type I was looking for. It is frequently reviewed for studies and computer calculations.

I found a certain minority of physicists—who I quickly identified and you didn't talk to anymore—who either lied or professed ignorance, and who I later found had had some relevant knowledge.

I would rather not go into very specific detail. This is certainly just an atmosphere. It happens too fast for there to be any specific communication or direction involved.

Finally, an incident occurred last week that I feel obligated to mention. When I first knew that I was to appear here today I went to my division manager and asked for company travel funds. I received them. When he mentioned this to his superior, the group manager, my funds were withdrawn.

The reason given was that this research was personal and not company sponsored, and therefore to use overhead money would not be consistent with government auditing procedures. You may have noticed that in my statement I was very clear to say this was personal research. Had my travel funds not been withdrawn I would probably not have been so clear, because in fact there is a very vague dividing line between company and personal professional interests. At my level, a professional interest of any type is likely to be a company interest. This Smoky investigation falls squarely into an area where the company has contracts. So I was a little surprised at what happened.

The second part of my answer is this: In order to obtain classified documents—let's say that I would like to obtain material from the DASIAC Library in Santa Barbara, the repository of a number of documents that bear on nuclear tests—I would need a clearance, which I have, and I would need a "need to know."

A need to know, for people in private companies—and I presume there are analogous rules for people in universities and foundations—means an active contract with the Defense Department and certification from the cognizant officer that the contract falls within the area of information requested. I understand that there is a procedure for obtaining information without an active contract, but it is primarily for filling gaps within a history of contracts.

So this regulation or law—I am not sure of its legislative status—means no one can look at classified documents, no matter how secure they are as U.S. citizens, unless they are approved by the Defense Department with funding. It seems to me that this is a very serious restriction of scientific inquiry.

Mr. **Ottinger**. I want to thank all three of you and ask if you have additional information that would bear on this if you could supply it in writing to the committee. I think it would be very helpful to us. We are going to be having other witnesses who are directly involved in some of the incidents that have been mentioned here today. I understand Dr. Mancuso will be before us, and the more background we can have on this the better we can operate, and I think maybe we can act perhaps to protect you and those in the future who may want to disclose things that they consider to be serious matters of protection of public health. I hope we can.

Mr. **Rogers**. The committee will certainly look into that, and I would also like staff to check into this business of a rule or regulation that people cannot have access even though they have security clearance unless they are doing contracts and the contract has to be approved by the Defense Department. It seems they are completely closed from the information they so desire.

Mr. OTTINGER. I thank you for your indulgence, Mr. Chairman.

Mr. ROGERS. Mr. Maguire, thank you for your patience.

Mr. MAGUIRE. Thank you, Mr. Chairman.

Dr. Morgan, on page 9 of your statement you say you are amazed and appalled, those are the words you use, at the large number of scientists who in spite of overwhelming data supporting the linear hypothesis say that we have no human exposure data at low doses, that the hypothesis is too conservative, et cetera.

I wonder if you would expand a little bit on that. You have used some very strong language there, and tell us a little bit more about what percentage of scientists fall in this category, as you have experienced it.

Are they only those associated with ERDA or with the Department of Energy, now, or are there others, and if you could, tell us a little bit about why you think this is so. The reason I am asking is that if we have trouble relying on the integrity of the scientific process and of those who practice the scientific method, we are in very serious difficulty, and I wonder if you would amplify that statement.

Dr. MORGAN. Yes, Mr. Maguire. I am sure this makes it very difficult for members of the public to understand what is true and what is false when scientists have so much difficulty agreeing among themselves, and when one group of scientists will take a mass of research data and arrive at one answer whereas another group will arrive at a contrary position.

I think this is something that has been going on for at least all of my professional life to some extent. I was a member of the International Commission of Radiological Protection for a long time, I guess some 20 years, and I am now an emeritus member.

In this organization, for example, I mentioned Dr. Muller, the geneticist. He and I worked very hard for the passage of regulation or recommendation that because of the great risk of exposure to pregnant women and to the fetus that certain practices should be recommended to minimize this harm.

One of the recommendations that was made in that early period was called the 10-day rule. That reads, paraphrasing it somewhat in this manner:

That where practical and possible, without immediate harm to the woman, X-ray, to women in the child bearing age on the pelvic and abdomen region, be limited to the 10-day interval following the beginning of menstruation. It seemed to Dr. Muller and myself that this was a great day, a great accomplishment, but following that the American College of Radiology, a group, maybe it's a question of who are scientists, in this context I am calling radiologists scientists, certainly as a professional group they did not support this position, and even today many of them feel that this recommendation is not substantial, that it is not beneficial, although from my many contacts overseas I am convinced that it is practiced rather carefully there, and that the scientists there do believe that low level exposure is significant, especially to the fetus.

Mr. **Maguire**. What I am trying to get at, Doctor, if I may interject, it seems to me in your statement, particularly since you refer to those associated with ERDA, there is an implication that the scientific data is going to be assessed differently by people depending on who is paying them and what they feel their obligations are to whatever group it is that they are related to. Is that a correct reading of this statement? Do we have, in other words, disagreements among scientists in cases like this because of genuine differences in the data and genuine scientific debates about how data ought to be evaluated, or do we have, in fact, something quite different, namely, people telling their employers or the groups with which they are associated what they believe those employers or groups wish to hear. And if there is an implication that it is the latter, are we still dealing with science or are we dealing with something else?

Dr. **Morgan**. This really puts it on the line, and I think this will be addressed more specifically perhaps on February 8 when Dr. Mancuso specifically is before us. But, if I may refer to that at this moment, since the inception of that program to evaluate the consequences or possible consequences of low level exposure to workers at Hanford and Oak Ridge, this program, Dr. Mancuso's program was set up under Dr. Mancuso at the University of Pittsburgh, and from its inception, because of my activities in this field from the beginning of the atomic age, I was asked to be a member of the advisory committee for this program. So I followed it with great interest from its very beginning.

The program progressed for many years, and it took a long time to collect this data, to follow these persons to the time of their death, determine from death certificates the cause of the death, to try to determine the dose they had received from the records, but things went fairly well with the Mancuso program until a man by the name of Dr. Samuel Milham with the Department of Social Health and Service in the State of Washington took a look at the data for the Hanford workers and published an in-house paper showing that there was, in fact, an increased incidence of malignancies among the Hanford workers, an increase that was of statistical significance.

At that time this was rather alarming to some of those in the atomic energy circle who had been, could we say, getting on their soap box and saying there is no risk of cancer working in this industry. I had cautioned them, I had pleaded with them not to make that claim, because I felt that there was a risk, a small risk, and perhaps an acceptable risk, but you can't say no risk.

When Samuel Milham found this data pressure was brought on him, and I understand he probably will be at the hearing next month so he can speak for himself, but there is no doubt that his data did not reach the light of day and the open press, the scientific publications, until many, many months later when the data was finally published in a rather obscure journal.

When this positive finding developed with reference to the Hanford workers and was developed by Dr. Milham, great pressure was brought on Dr. Mancuso to come out with it, get your data in publication, because to that time he had found no indication that there was an increased incidence of malignancies in these people.

Mr. Maguire. You believe, I take it, that the Mancuso study is a valid epidemiological study, correct?

Dr. Morgan. I believe it's a valid epidemiological study, taking together all of the animal studies that I have examined, and there are many thousands of them through the years. It's hard to understand how such low level can bring about such large, demonstrable effects in a human population. But I think as far as I am able to evaluate the statistics and as far as some other well thought of statisticians and epidemiologists are concerned, their method seems valid, and I am willing to accept it at this point, and I don't want to see it brushed under the rug because they are the wrong answers.

Mr. Maguire. Do you agree with Dr. Tamplin's statement that on the basis of this and other data the indication is that estimates of the effects of radiation, both for cancer induction and for genetic effects, are too low by at least a factor of 10? Would you go that far?

Dr. Morgan. Let me say it this way: To me there is no doubt that the levels would be too low by a factor of 10 for certain members of the population. Maybe, I think there is no doubt in reference to the fetus. I believe it's the most sensitive and radiosensitive member of the population.

Mr. Maguire. With respect to a fetus, by the way, we are talking about the possible effects of a single ray, that kind of thing?

Dr. Morgan. Yes.

Mr. Maguire. We are not just talking about smoking tests where troops are marched practically to ground zero in an hour. We are talking also about fetuses, exposures to one or more discreet X-rays.

Dr. Morgan. Right. Dr. Alice Stewart's data, and she is, I understand, in the States at the present time, working again perhaps with her own funds on the Mancuso program, her data gave a straight line beginning with zero. If you plot the number of malignancies as a function of the number of pelvimetrys that the women receives, and the curve, straight line is the best fit for the data she has.

Mr. Maguire. Is the linear hypothesis always, in your judgment, based on the data you have, a better hypothesis, better than some curval linear hypothesis, that is, either curve that meant you had fewer at low levels of dosages than you would expect under the linear hypothesis or alternatively, a curve that had more than would be expected under the linear hypothesis. I mean, why is the linear hypothesis better than either one of those alternatives?

Dr. Morgan. I try to keep a flexible mind, develop theories as I go and look at other people's theories, but I am one of those that believes that scientific data, that facts from experiments are things you can't ignore, and when someone like Milham, Ross, Alice Stewart in England, Mancuso's program with the Hanford workers, when these data indicate that the best fit is a linear relationship, I shouldn't forget the studies of the refugees into Palestine, the 11,000 there that were given X-rays to the head for tinea capitis, or ringworm, that in that case the average dose was only 6½ rad, a very small dose, and yet they showed up with thyroid carcinoma, and this points precisely to the curves that were developed by others in the past, and so I feel that certainly there are groups in the population for which the best fit is a linear relationship.

I would say it applies to the fetus, it probably applies to the infant, and it probably applies to the older people.

I was interested among the Hanford workers that the Stewart-Mancuso data seems to indicate that they likewise are more radio sensitive, which confirms other data. Though it will be hard to convince me that there aren't animal studies that are acceptable where there is so much repair that a curval linear relationship seems to fit the data best. This seems to apply to certain types of effects on animals exposed to low LET radiation, that is X-rays, as against neutrons or alpha particles, and perhaps animals which are not infants or not fetuses or not in the older category.

Mr. **Maguire**. In some cases you also believe the linear hypothesis is too conservative?

Dr. **Morgan**. In some cases I believe it is too conservative, but I have several publications that to my satisfaction show that it isn't sufficiently conservative. So it depends on the effect you are looking at, the age of the group, other insults to which the population may be subjected.

Mr. **Maguire**. One final question, and I appreciate the forbearance of the chairman.

The statement that you make on page 2 that you have shown that medical exposure could be reduced to 10 percent of the present amount, and while at the same time improving medical radiography, I looked up the references at the back of your statement and found that the references were 1967 in testimony before congressional committees.

My question is, has Congress done anything or has anything been done in medicine in the intervening 10 years to improve the situation?

Dr. **Morgan**. I think some weak attempts have been made to follow up on the good work that Senator Bartlett from Alaska got started, but I have been very disappointed that following his death the agencies responsible, at least in one count, have not followed through. Let me mention specifically what I have in mind.

For years I and members of the American Society of Radiological Technicians and others have attempted to get some legislation that would require the appropriate education, training, and certification of all X-ray technologists. To the present moment, this has not been accomplished. There are only a few States, New York, New Jersey, California, Kentucky, where these radiologists that operate machines do not have to have what I consider the minimum requirements of education. Only in the State of California are doctors required to take certain courses and do have questions on the State board examination dealing with the effects of radiation on man.

Yet the doctor purports to have the responsibility to weigh the benefits of an X-ray against the risk, and yet in many cases he has almost no knowledge. I have difficulty in Atlanta finding a dentist that knows enough about the protective measures of radiation that I feel safe to go to, so I still go back to Oak Ridge where we have trained a few of the genetists in proper use of X-ray.

Just to illustrate it, most of the dentists in my area in Atlanta still are using the plastic type pointed cone rather than the long open-ended cone that for years has been recommended by the American Dental Association. Only a few percent of them use a rectangular collimator and yet the film is rectangular. A beam comes out like this, and the film like that. It doesn't make much sense.

You said these papers I gave here date way back. I have more recent papers. One was published recently in Germany, and I could send you some other papers of recent date that show the situation hasn't improved much. We have had one or two very marked successes. The mass chest X-ray program is now out the window. It is forbidden in this country, though the Surgeon General in this country for years fought to try to discontinue the mass chest X-ray program, but the radiologists and others pushing it prevailed, and the program went on for years. So our little kids in the grade schools had to march in through these buses that were brought up and they were X-rayed. It would have been much better had they been branded with a hot iron rather than X-rayed. It would have been much less harmful because some tests we made, some of these devices were giving very large doses, up as high as 3,000 millirad to the skin when in our lab we showed with proper techniques they could get a better radiogram with 10 milligrams.

In some of these hearings I think the Senators and others were very sincere in trying to get on with the job. But we can't point to very many successes. The State of Illinois has set certain limits on certain common medical procedures. The Environmental Protection Agency has recently come out with a similar recommendation on these. I am not sure whether they have gone into law at the present moment. So progress is slow, and some of the more important things we need are still on the back burner.

Mr. MAGUIRE. Thank you.

Mr. ROGERS. Thank you. As I recall, when we wrote the Radiation Health and Safety Act we authorized HEW to set standards for the manufacturers to make sure that equipment is constructed for safety. I think we will look into that, because as I recall, that should be a current authority that just maybe never has been exercised.

Dr. MORGAN. I think you are right, and that is where the principal emphasis has been placed, I believe, as far as the Bureau of Radiological Health of HEW. In the case of color TV, for example, I got on that committee under Russ Morgan, and we decided that rather than spend hundreds of millions of dollars to call in and check all color TV's, to spend lesser funds and to try to immediately get off the market those sets that were producing large exposures of X-rays. The vast majority of these sets gave an insignificant dose, but some tests carried out by the Bureau of Radiological Health showed terrific doses could be delivered to kids that get their noses up against these devices.

Mr. ROGERS. Thank you. Let me just ask two questions.

Could you recall the name of the jeep driver, the people that you sent in to this Smoky test. Would your records maybe reveal that?

Dr. MORGAN. Yes.

Mr. ROGERS. Who had to turn back?

Dr. MORGAN. What we did, we had to put instruments in these houses, and we had retrieved them within minutues, so we were at the control point, I think it was 8 miles away, I forget the distance. I covered many tests, but not that one, and the man was called Barney Hensley. I am not sure whether he is still living or not, but the fellow in charge of the program was Dr. J. A. Auxire, and he was in the truck at the time. He happens to be the present president of the Health Physics Society, so he is someone knowledgeable.

Mr. ROGERS. Do you know where he resides?

Dr. MORGAN. He took my place at Oak Ridge after I left.

Mr. ROGERS. So we can contact him there.

Thánk you.

Then let me finally conclude by asking you, do any other nations' standards vary from ours?

Dr. MORGAN. Yes. Certainly the enforcement of the recommendations of the International Commission varies from one country to the other. The National Council on Radiation Protection and International Commission don't make laws or codes, but they do have in some cases the teeth and the effect of law. In some countries they are much more careful about exposures to pregnant women, for example, than I believe the majority are in our country.

Mr. ROGERS. I presume we could get a comparison of that.

Dr. MORGAN. Yes. I think from some of the statistics gathered by the Bureau of Radiological Health and by the United Nations Scientific Committee.

Mr. ROGERS. We will try to do that.

I understand also that Russia, for instance, on microwave ovens, has a standard that is 1,000 times stricter than ours.

Dr. MORGAN. Yes. In our country the level for microwave is 10 milliwatts per square centimeter, whereas in the Soviet Union it is 10 microwatts, 1,000 less. Recently the Bureau of Radiological Health has set lower limits for the ovens themselves. I believe the figure is, and maybe I am wrong in this, I believe it's 1 milliwatt per square centimeter for a new microwave oven, and they allow it to go up to 3 milliwatts per square centimeter after it has been in use for a while, but that is still a long way from the 10 microwatts that they are using in the Soviet Union.

Mr. ROGERS. So they are much stricter on microwave in Russia than we are.

Dr. Carter?

Mr. CARTER. Thank you, Mr. Chairman.

I just have one or two questions I would like to ask.

Dr. Morgan, or any of you gentlemen, are you familiar with the Baneberry atomic explosion?

Dr. MORGAN. I am not.

Mr. CARTER. That was an underground explosion which vented, or blew its top. Are you familiar with it, Dr. Tamplin?

Dr. TAMPLIN. Yes, I am familiar with it. I don't know any of the numerical details of it at this point, but I do recall it was one of those unsuccessful tests where it vented and at that time the Public Health Service measured iodine in milk over fairly substantial areas there.

Mr. CARTER. Dr. Sperling, do you know any of the details of that?

Dr. **Sperling.** No; I am sorry I don't.

Mr. **Carter.** I believe that is the one in which the AEC base camp was evacuated and 13 security guards worked unprotected in the radioactive cloud which resulted from the venting. Of the 13, 3 have died of leukemia.

Dr. **Tamplin.** As I say, I don't have the particulars, but I know there was one shot that vented there, and for some reason or another the wind was blowing the wrong way, and it blew back over the base camp and that may well have been Baneberry.

Mr. **Carter.** One other question: Was Smoky a particularly dirty blast?

Dr. **Morgan.** As I indicated before, my group had the responsibility for the dosimetry of the survivors at Hiroshima and Nagasaki, so we covered numerous tests in Nevada and the South Pacific, and I talked to Dr. Auxier, who I mentioned, and he said this was, his words, the dirt is of the tests he covered and the only one where the fallout was so high we did not recover our instruments.

Mr. **Carter.** Do you think it possible that if a nuclear bomb is set off in China or Russia, a huge one, that the fallout could get in the jetstream and settle into the United States, be ingested by people or be deposited on grass which could be eaten by cows and the cow's milk in turn be ingested by humans and cause ill effects, including cancer?

Dr. **Morgan.** Mr. Carter, on the linear hypothesis, there is no question that the answer to your question is yes, that it is just a matter of how much chance. Is there 1 chance in 1 million, 1 chance in 10,000, and even 1 chance in 10,000 when multiplied by 200 million is still a large number of people that could get cancer as a consequence.

Mr. **Carter.** If we attempted to destroy Russia with every atomic weapon at our disposal and they landed successfully in Russia then, to destroy Russia, in turn we might be destroying ourselves through the fallout getting into the jetstream and coming back over our country. Is that correct or not?

Dr. **Morgan.** That is correct, and there are numerous studies that show what the levels would be in our country if the war were restricted to one, say, in China, or between China and the Soviet Union.

Mr. **Carter.** Thank you very kindly, gentlemen; you have been wonderful.

Dr. **Tamplin.** I might say the material would not necessarily have to get in the jetstream to get back here. The only thing the jetstream does is get it here faster. I think in 1966 there was a test in China and the material did get here within 3 days and caused substantial fallout in California, and the implications of that were had it rained while that material was passing through California, the iodine concentration in the milk would have exceeded the allowable concentration that the Federal Radiation Council had permitted.

Mr. **Rogers.** How often are the radiation standards changed?

Dr. **Tamplin.** The last change was, I think, 1956.

Mr. **Rogers.** We have not changed them since 1966, even though the data seems to indicate they should be tightened?

Dr. **Tamplin.** No.

Mr. **Rogers**. Who makes the change?

Dr. **Morgan**. The Federal Radiation Council was set up with the authority and responsibility, and that was taken over by the Environmental Protection Agency. They set the standards ostensibly for the population at large and then the NRC sets the standards for the reactors and the other operations under their jurisdiction, but there seems to be a gray area overlap between the two agencies. I am not sure how that is resolved.

Then, of course, the Bureau of Radiological Health also assumes some responsibility in setting standards. So I think one of the problems is the division of effort between some of our governmental agencies.

Mr. **Rogers**. And there is no mechanism to require an automatic review of the standards; they just kind of get together and decide?

Dr. **Morgan**. Apparently no formal arrangement. A few years ago, when the question was very important about transportation of radioactive materials, then, of course, several other Government agencies got into the act, and it appeared to me in some of the discussions I had that part of the problem was that some of the important elements fell between the cracks, as far as these agencies, in this case transportation of radioactive material.

Mr. **Rogers**. I understand for the radiation workers the 5 rem was recommended in April of 1956, so that hasn't been changed for some time, then; is that right?

Dr. **Morgan**. That is right.

Dr. **Tamplin**. Not since 1956. It is interesting before that was set, the Atomic Energy Commission was quizzed to see if the nuclear power industry could live with it, and it turned out that they felt they could.

The problem and the reason why these things are not being changed today is basically that they don't think the nuclear power industry could live with reduced radiation standards.

Mr. **Rogers**. You know that is what they also said about clean air standards. We have been through that before.

Dr. **Tamplin**. It is the same answer.

Mr. **Rogers**. Also, we would like to submit questions that have been prepared to each of you to answer for the record, if you would, when you have time, so that we can have the benefit of your thinking on certain other subject matters we have not had time to cover in public meeting.

We are grateful to each of you and appreciate your effort to be here and share your knowledge with the committee, Dr. Morgan, Dr. Tamplin, and Dr. Sperling.

We are grateful to you for being here. Thank you, and we may be in touch, and any additional information you think we need, we will be pleased to receive. We are grateful to you for your presence today. Thank you.

[The following letter from Dr. Morgan was received for the record:]

SCHOOL OF NUCLEAR ENGINEERING

Atlanta, Georgia 30332 (404) 894-3720

February 3, 1978

Congressman Paul G. Rogers, Chairman
Subcommittee on Health and the Environment
of the Committee on Interstate and Foreign Commerce
Room 2415
Rayburn House Building
Washington, D. C. 20515

Dear Congressman Rogers:

First of all I would like to congratulate you on the well conducted hearings on Effects of Low Level Exposure which were held in Washington last week. Florida is a second home for me (I have a cottage at Indian Rocks Beach, Florida), and I'm proud that our state has someone of your stature in a position of leadership in the Federal Government.

At the conclusion of the hearings you requested two things: (1) Answers to a list of written questions which were handed to me by your assistant and (2) Identification of cases where government agencies have censored or repressed scientific information.

The questions and my answers are as follows:

1. What are the different types of ionizing radiation and what types of adverse health effects can result from exposure to each type of ionizing radiation?
Ans. There are some 90 types of high energy ionizing particles that have been discovered. However, for work about nuclear reactors or their products or for exposure from nuclear weapons we only need consider α, β, γ, x-rays, and neutrons. In the medical professions we are concerned mostly with x and γ radiations and to some extent with internal exposure to I-131, Tc-99m, P-32, etc. Also, in the nuclear energy field we can be irradiated both externally by these radiations and internally when we inhale or ingest radioactive products produced by the nuclear reactions. Radionuclides taken into the body can irradiate the lungs or GI tract as they reside there temporarily and/or portions of them can be incorporated into body organs. For example plutonium as an insoluble compound may have a $T_{1/2}$ ($T_{1/2}$ = time for half of it to be removed by radioactive decay plus biological elimination) of 1 month to 10 years in the lungs but in the bone $T_{1/2}$ = 200 years. In the case of I-131 in the thyroid $T_{1/2}$ = 7.6 days or for Sr-90 in the bone $T_{1/2}$ = 18 years.

In regard to the adverse effects of radiation I am enclosing some of my publications which describe this in more detail. In short, however, there are the acute effects from high exposure. These include erythena (like sunburn), epilation (loss of hair), nausea, loss of appetite, etc. If the doses were very high, there would be sharp reduction of formed elements in the blood, infection in the GI tract and death within hours (at 50,000 rem) to weeks (200 rem). The chronic effects include production of all types of cancer, general life shortening, eye cataracts, etc. There are complete discriptions of these effects in my text "Principles of Radiation Protection" by K. Z. Morgan and J. E. Turner, R. E. Krieger Publication Co., 1973.

2. What sort of risks accompany exposure to radiation, such as that from medical x-rays, or occupational exposure of those working with radioactive materials?
Ans. This is answered in detail in the enclosures.

3. Does the current occupational exposure standard of up to 5 rem/year provide sufficient protection against undue health risks?
Ans. I think probably the present maximum permissible exposure (MPE) for occupational workers of 5 rem/y would be acceptable if on the average radiation workers did not receive more than 5 to 10% of the MPE. However, many of the electrical power companies are averaging more than 50% of the MPE and I think this is too much. I object especially to the practice of "burning-out" of temporary employees.

Every occupation has its peculiar hazards. On page 515 of my text (see above reference to Krieger Publication) I give seven reasons why occupational exposure should be higher than that permitted to the population at large. If a worker received 5 rem/y average for 35 years, his risk of radiation induced cancer would be about,

$5 \times \frac{1}{2} \times 35 \times 3 \times 10^{-4} \times 100 \approx 2.6\%$ chance of a radiation induced cancer. I think, this is too high even though the normal cancer risk is about 20%. I would think, however, a risk of 0.26% might be acceptable in terms of the benefits of employment and of the uses of radiation. I would like to qualify the above statement, however, because the studies of Mancuso, Stewart and Kneale would indicate the cancer risks may be 25 times more than the 3×10^{-4} c/rem suggested above. In such case the risk of 30 years exposure at 5 rem/y would be about 65% and this or even 6.5% from 0.5 rem/y average are far too high. Also the long term genetic risk is about the same as the somatic risk, viz. 2.6% from 35 years exposure at 5 rem/y.

4. There has been some suggestion that internal α-particle emitters are responsible for a significant fraction of environmentally induced cancers, including lung cancer due to cigarette smoking. What is the current status of this theory? Are internal α-emitters believed to contribute to disorders besides cancer?
Ans. I believe there should be no question but that α-emitting radionuclides such as ^{226}Ra, ^{222}Rn, ^{218}Po, ^{214}Po, ^{210}Po, ^{216}Po, ^{212}Po in our natural environment (including cigarettes) are a major cause of our indigenous malignancies. An even larger contributor in the U.S. is the excessive and improper use of x-ray diagnoses. It seems also that naturally occurring ionizing radiations account for 10 to 30% of all genetic mutations.

5. What is the "warm particle" theory of cancer induction?
Ans. I was chairman of the internal dose committees of both the international body (ICRP) and the national body (NCRP) that set the permissible body burden and MPC's for all the radionuclides for over 20 years and as such was one of the first to raise the question about the risk of "hot particles." Radiation dose (R in rem/y) from a point source decreases as the square of the distance X from a point source; that is

$$R = \frac{I}{X^2}$$

in which I = rem/y at 1 cm distance, obviously if $X \to 0$, the dose rate $R \to \infty$. In the practical case for something like ^{239}Pu even a 1 μ particle (1 μ = 0.0001 cm), i.e. 1/1000 the size of a pinhead, would deliver over 1000 rem/y to the adjacent tissue in the body. Of course this would destroy or disfunction nearby tissue, but I believe it would increase the risk of a malignancy in tissue 10 μ or more distant. There is some experimental evidence for this (studies of R. Thompson at Hanford). Don't forget when Miriam Finkle (Argonne Laboratory) some 30 years ago put 1 μg quantities of radionuclides into the skin of rats and got 40 to 60% incidence of cancer. In spite of such evidence, EPA, ERDA, NCRP, etc. have happily concluded the risk of hot particles is negligible and less than when the same amount of radioactive material is diffused uniformly in the body organ. The scientific evidence is contradictory and I believe in such case what we need is more research evidence — not more committee or government agency omnipotent and omniscient opinions.

6. What areas need to be explored further before we can accurately assess the risks due to exposure to ionizing radiation or radioactive materials?
Ans. Some of the areas that badly need exploration are:

a. Hot particle problem.
b. Cancer risk from Pu, Am, Cm, etc. when inside body.
c. Better methods of determining the microdose of α-emitters (my students are doing some of this now).
d. Behavior of Pu and Am in the environment. For example some studies suggest the availability of PuO_2 and AmO_2 in the environment is 1000 times what is commonly assumed.
e. Methods of reducing occupational exposure in the PWR and BWR reactor systems.
f. Better methods of reducing exposure in underground uranium mines.
g. Risks associated with ^{85}Kr, ^{129}I, ^{14}C and ^{3}H in the environment.
h. Strong support for the Mancuso-Stewart-Kneale program at the University of Pittsburgh and of the Bross Tri-state study. They should not be in-house programs.
i. More followup on cases of medical exposure (e.g. in intero exposure, mammagrams, dental x-rays, etc.).
j. Extensive followup of service men exposed during atom bomb exercises.
k. Also, we badly need studies of effects of non-ionizing radiations on man.

7. Does the recent study of Dr. Thomas Mancuso, Dr. Alice Stewart and George Kneale demonstrate that a significant risk of serious health effects occurs at doses of radiation previously thought to be safe?
Ans. At the present time the answer is a resounding yes. Perhaps future studies or extension of these studies (not under an inhouse program at Oak Ridge) will indicate it was unidentified internal exposure to Pu, Am, etc. (usually associated with persons having high γ- exposure) that caused the high cancer risk to be about 25 times what we here-to-fore have thought. However, in the meantime we must be conservative and not use humans as guinea pigs.

8. Does the recent study of Dr. Irwin Bross also show that a significant risk of serious health effects occurs at low levels of radiation exposure?
Ans. Yes. I think there is no question that Dr. Bross has shown there is a large synergistic effect associated with radiation exposure.

9. At the time of the Nevada atomic test series, what levels of radiation exposure were considered to be safe?
Ans. I have reason to believe that during this early period many military men thought exposures up to 100 rem of γ-radiation were relatively safe and exposure of β-radiation (even up to 10,000 rem) were safe. I suggest one get from the Pentagon a copy of the Manual currently used by our troops (and our allies). Here one is shocked to read that 100 rem is relatively harmless.

10. What was known about the adverse health effects of ionizing radiation in 1957, the year of the Smoky blasts and other tests involving military maneuvers?
Ans. In 1957 most persons thought exposures less than about 25 rem were of little significance. The chronic risk of cancer from low dose was considered to be 1/10 to 1/50 th of what we know it to be today.

11. What was your personal involvement with the Nevada and other bomb test series?
Ans. At that time my Health Physics Division at ORNL (of which I was director) was in charge of determining the dose received by the survivors of Hiroshima and Nagasaki, Japan. We built Japanese houses at the test sites and put instruments in them to determine the dose at various locations. Thus, I and/or my teams were present as participants at many of the tests in the South Pacific and at the Nevada Test Site.

12. Was the Smoky blast considered to be unusually "dirty" in terms of radioactive fallout?
Ans. Yes. Our instruments in the Japanese houses were encased in steel balls which were attached to a long chain running up the road from the test sites. We had to recover our instruments within about an hour after detonation of a weapon. Thus, immediately after the blast we drove toward point zero, fastened the chain to our truck and drug the instrument balls to a distance where it was safe to put them in our trucks and rushed them to our trailer where the doses were evaluated. I was not present at test Smoky, but Dr. John A. Auxier

(now director of Health Physics and Safety at ORNL) was in charge of our Smoky tests. On this morning he was reading the portable radiation meter (ion chamber) as the truck approached point zero and the truck was traveling (I suspect) about 70 MPH. At a distance of 3 to 4 miles from point zero John called to the truck driver to stop and turn truck around (and hi-tail) because the meter needle was going up scale very fast and already reading 10 rem/hr. This was the only test of the many we covered in which the fallout was so heavy we failed to recover our meters.

13. In your opinion, were civilian and military personnel participating in Smoky and other A-test operations exposed to levels of radiation which would increase their risk of adverse health effects, such as leukemia?

Ans. Yes. I believe we have very strong evidence to support the linear hypothesis that says there is no safe level of exposure to ionizing radiation and that the risk increases in proportion to the accumulated exposure. Present evaluation of human populations suggest the risk of leukemia over 30 years after x-ray exposure is about 10^{-4} leukemias per rem. In the case of Smoky I believe the doses were many times those reported by the military. I believe I am the first person who ever used geiger counters (GM counter) for radiation monitoring (health physics) and since 1931 when I used GM counters in cosmic ray research, it has been known by persons familiar with GM counters that they paralyze (or the needle drops to zero in high dose rate areas) because of their long time constants. If the military depended on GM counters it would be like trying to use a flashlight in the dark with dead batteries. I am told that GM counters were used, but I do not know whether on Smoky they may also have had available ion chambers. Also, I suspect the film badges read less than 1 rem because the exposure was so large (10 to 200 rem) and there was a reversal in the film emulsion. It is well known that a photographic film such as used in the military film badge reads zero dose after very large exposure. If 10,000 persons were exposed to:

1 rem, we would expect $1 \text{ to } 2 \times 10^{-4} \times 1 \times 10^4 = 1 \text{ to } 2$ leukemias

10 rem, we would expect $1 \text{ to } 2 \times 10^{-4} \times 10 \times 10^4 = 10 \text{ to } 20$ leukemias

100 rem, we would expect $1 \text{ to } 2 \times 10^{-4} \times 100 \times 10^4 = 100 \text{ to } 200$ leukemias

14. Do you think the AEC and those conducting the war games accurately estimated and measured the amount of radiation received by participating personnel?

Ans. No. Answer given above.

15. Do you know of a study being done by Rotblat concerning health problems experienced by those entering Hiroshima shortly after the bomb was exploded?

Ans. Yes, I have a copy of this paper (copy enclosed)

16. What sort of short-term physical effects result from exposure to a nuclear explosion? (i.e., "radiation sickness?")
Ans. Answer given above and in Text of KZM and JET.

17. To your knowledge, did any personnel taking part in the Smoky or related operations experience any of these short-term health effects?
Ans. I have received phone calls and letters from persons who claim they experienced some of the effects that are common with the human acute syndrome and that I have noted among humans that have been involved in radiation accidents.

18. Have you ever in your career in health physics been asked by the government to refrain from disclosing to the public your concerns over the adverse health effects of ionizing radiation, particularly in connection with specific AEC sponsored projects?
Ans. Many times I was cautioned not to exaggerate the risk estimates associated with exposure to ionizing radiations. I published some of the earliest papers showing the risks from internal exposure. For example a paper "Tolerance Concentration of Radioactive Substances," K. Z. Morgan, J. of Physical and Colloid Chem. 51, 584 (1947) was delayed in publication for over a year because I showed the level being used for ^{210}Po in weapons production plants was far too high for the safety of radiation workers. Most of the conflicts I had were with persons in charge of programs at ORNL. My worst experience was when a paper I was to give in Neuherberg, Germany (July 5-9, 1971) was censured and the portions showing the LMFBR from the standpoint of Pu and other heavy elements was 270 times less safe than the thermal breeder operating on the Th-^{233}U cycle, the words, were deleted. Enclosed is a copy of my original paper and of the chopped-up (censured) version that was later published by the IAEA.

Mr. Rogers. Now, we will show a film from the Department of the Army that was made during the nuclear test "Smoky" in August 1957.

I will ask now for them to prepare for the film on Smoky. Is there someone from the Army that could quickly introduce the film? Could you identify yourself for the reporter.

STATEMENT OF MAJ. DONALD A. DELINE, DEPARTMENT OF DEFENSE (ARMY)

Major Deline. I am Maj. Donald A. Deline, from the Department of the Army, and the film consists of pictures that were actually taken at Shot Smoky and an explanation of what went on during Shot Smoky. There is a little acting in it, but most is actual pictures of the shot.

Mr. Rogers. Thank you. Whenever you are ready, we will have the lights out. I am advised the film is 28 minutes.

[Showing of film.]

Mr. Rogers. Do any of the witnesses have any comment on this at all?

Mr. Morgan. Just to thank you for the opportunity.

Mr. Goodman. My name is Leo Goodman. I have been working on this problem for 25 years. I would like to call the committee's attention and those in the audience that while we have been meeting here this afternoon, the U.S. Government has been assembling a number of teams to be sent to Western Canada because a Soviet satellite bearing a reactor came down through the atmosphere and burned up and will be shedding radioactivity in the form of fallout for the next few days over the United States.

Mr. Rogers. Yes, we saw those reports. Thank you very much, Mr. Goodman.

We are grateful to the witnesses and, Major, thank you for arranging for us to see this film.

Our hearings tomorrow will have witnesses who have been on the scene at Smoky and we will hear also from the Department of Defense, the Department of Energy and the Center for Disease Control, as well as a few other witnesses. It will be a full day so we will begin hearings at 9:30 in the morning in this room. Therefore, the committee stands adjourned until 9:30 tomorrow morning.

[Whereupon, at 5:10 p.m. the subcommittee adjourned, to reconvene at 9:30 a.m., Wednesday, January 25, 1978.]

EFFECT OF RADIATION ON HUMAN HEALTH

Health Effects of Ionizing Radiation

WEDNESDAY, JANUARY 25, 1978

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON HEALTH AND THE ENVIRONMENT,
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:50 a.m., in room 2123, Rayburn House Office Building, Hon. Paul G. Rogers, chairman, presiding.

Mr. ROGERS. The subcommittee will come to order, please. If we can just close the door, please.

Today, as the Health and Environment Subcommittee continues oversight hearings on the health effects of radiation, we will examine the possible link between radiation exposure resulting from the U.S. nuclear weapons test program and increased incidence of leukemia and other cancers.

In the last several months, public attention has focused on the so-called Smoky atomic blast of August 1957. More than 3,000 military personnel were present in this test. A weapon three to four times the size of the bomb dropped on Hiroshima was detonated from a steel tower 700 feet above the desert floor. Over the 20 years since the blast, some of the military personnel participating in Smoky have contracted leukemia. One of those individuals is Mr. Donald Coe, a constituent of Congressman Tim Lee Carter, the ranking minority member of this subcommittee. His plane this morning has been grounded for weather reasons, but we anticipate that he will be here this afternoon. We have other witnesses, however, that are present and will be present this morning.

Congressmen Carter, I might say, has labored long and hard on behalf of Mr. Coe in his struggle with the Veterans' Administration for disability compensation arising out of his radiation exposure at Smoky. I certainly commend Dr. Carter and his staff for the enormous amount of information uncovered on troop participation in the nuclear test program. Dr. Carter has shared this data with the subcommittee and in the process has made the work of the subcommittee much easier.

After the Smoky blast and the related troop maneuvers became matters of public controversy, the Center for Disease Control in Atlanta began an epidemiological study to determine whether exposure to the blast resulted in increased cancers among those present. Representatives of the Center for Disease Control are with us today to review the status of their study. I am somewhat disappointed that no other followup on the persons involved has come to public notice.

Since the subcommittee began preliminary investigations of this matter in mid-December it has become clear that the Smoky blast and the troop involvement in that atomic test was by no means a unique event. Apparently there were at least 21 nuclear tests in Nevada from 1951 to 1957 which involved nearly 60,000 military participants and approximately 20,000 civilians. From 1946 to 1958, at least another 75 tests were conducted in the Pacific, involving unknown thousands of military and civilian personnel.

Today's hearings, we hope, will focus on several questions. First, how many military troops and civilians participated in or observed the test blasts during the U.S. nuclear testing program from 1946 to the present? and second, is there an excessive incidence of leukemia, or other cancers, or any other disease among those exposed to these nuclear tests? and third, if such an increased incidence of disease occurred, what is its cause? Is it an overexposure to high levels of ionizing radiation which were not measured by radiation-monitoring devices? Or is the cause ionizing radiation at levels previously and currently generally regarded to be safe?

The import of these questions cannot be overestimated. If there is an increased disease incidence related to participation in these tests and if we determine that the radiation exposures were greater than measured at the time, then serious questions arise about past and present radiological safety programs. However, if it was low-level radiation which caused increased disease among troops and other participants in the atomic blasts, then present radiation exposure standards are completely inadequate. These present standards, identical to those applied in the 1950's nuclear testing program, continue to apply to all public and occupational radiation exposures.

And then, in addition, the committee is very concerned that all followup studies of the participants in the nuclear weapons testing program be designed, conducted, and funded so as to guarantee their complete independence. We are concerned that agencies with an obvious financial or policy interest in the studies' outcome, or with a continuing involvement in litigation stemming from the testing program may have a conflict of interest if these health effects studies are left to their funding and control. We intend to work to assure that complete independence of all followup studies. Only then can the results of such analyses, I think, be above question.

I believe Dr. Carter has a statement this morning.

Mr. CARTER. Mr. Chairman, I want to thank you for the opportunity for this subcommittee, as part of our oversight of the radiation laws, to take a detailed look at the atomic testing program and its implications for public health.

Between 1946 and 1964 this Government detonated 183 nuclear devices in the atomosphere. Many of those, 18 before 1957 alone, involved military troop participants. We must bear in mind, however, that virtually all had military and civilian test personnel, even if troops were not involved in formal maneuvers.

Let me stress that there are few who more firmly support a strong defense for this country than you and I. I served, as you did, Mr. Chairman, in the armed services of this country. As one who was a combat medic during World War II, I know too well the price paid to keep this country strong and free. But I know as well that those who sacrifice for the defense of this country are entitled to compensation when they are disabled or die as a result of that service. For, as Abraham Lincoln enjoined us to do, we must "care for him who shall have borne the battle, and for his widow and his orphan."

Our subcommittee, of course, is looking at this issue as it relates to human exposure to ionizing radiation. But, Mr. Chairman, I do not think that we can completely divorce from this issue the separate and too often tragic, problems which beset so many of our former servicemen who were at these tests. We see some of these men here today.

As you have explained, Donald Coe will be coming later to testify. There is, however, another person who is unable to appear and tell his story, yet, without his persistent dedication to bringing this story out, it might not have been told. That person, of course, is Mr. Paul Cooper. I had the pleasure to meet Paul last August, and, while he is not here today, he is certainly here in spirit.

As a final note, Mr. Chairman, let me point out the very fine work that is being done by the Disabled American Veterans. The DAV has set up a special unit to help servicemen at these tests with their claims for service-connected compensation, and the DAV deserves special commendation for its efforts.

STATEMENT OF HON. JAMES T. BROYHILL, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NORTH CAROLINA

Mr. BROYHILL. Mr. Chairman, at this time, I would like to have submitted for the record a letter which I recently received from one of my constituents, Mr. Roy D. Huffstetler of Gastonia, N.C., who was exposed to radiation while serving in the U.S. Navy in 1946. I have been working with Mr. Huffstetler for some time now with regard to his claim for veterans compensation benefits. Mr. Huffstetler is attempting to be granted service-connected disability benefits for cancer which he has suffered for several years. He has graciously taken the time to address his particular situation with regard to his exposure to radiation for the benefit of the subcommittee members. Mr. Chairman, I believe that the subcommittee will find his remarks most beneficial to the members' consideration of this important issue.

[The following letter is submitted for the record:]

GASTONIA, N.C.,
February 22, 1978.

DEAR SIR: I wish to take this opportunity to express my sincerest appreciation for your interest and concern in my disability and for the assistance that you have given me.

I was assigned to the Marshall Islands in May or June of 1946 for the Atomic Bomb test "Operation Crossroads". I was first stationed on the LCT 1420. The LCT 1420 duties were to assist deep sea divers, via a crane operation, in the inspection of sunken ships caused by the A bomb blasts.

I was assigned to the U.S.S. *Conserver* ARS 39 in September, 1946 at Kwajalein Island in the Marshall Islands. All the ships at Bikini had been towed to Kwajalein. It was our duty on the U.S.S. *Conserver* to keep the ships afloat and in order to do so, we had to board the ships to pump the water out and keep them afloat in order that the damage could be examined.

After "Test Baker", the battleship "New York" was towed to sea to remove the ammunition in order that she may be towed to Pearl Harbor. We also worked almost four days on the "New York" to remove her propellers in order to tow her easier. Other ships were also towed out to sea.

We also boarded the U.S.S. *Independence*, a light carrier, to start the generators and raise the anchor in order to tow her to Pearl Harbor. We were on about all ships that did not sink in the tests.

Additional information can be obtained from the book "Operations Crossroads", The Offical Pictorial Record, published by William H. Wise and Company, Inc. New York, 1946.

The Department of Navy has acknowledged that my records do not indicate the use of film badges for exposure. I did not wear film badge but about three days the entire time I was there. Personal records were inadequately kept, but ship's records would probably give details such as the time I received a small laceration on a small LSM and later it became seriously infected.

There were several cases of pilferage among the servicemen that I was assigned with. I cannot help but wonder if many of the personnel became ill or perhaps died because all the equipment, tools, clothing, etc. were taken by them. In one instance, one of the officers took a radioactive water valve and kept it under his bunk for a period of time. He died ten or twelve years later from the effects of radioactivity. The water valve was evidence in a court-martial and the officer, stationed on another ship, was the defense attorney in the case.

I was first treated for skin cancer in 1961 by Dr. John Bond, Gastonia, North Carolina and in December of 1975, my right lung was removed at the VA hospital in Columbia, South Carolina. I am presently an out-patient and am still being treated for my surgery and on February 10, 1978, my last checkup, it was discovered that I have another small skin cancer on my left ear that will have to be removed. At my last check up I was notified that there has not been an re-occurrence of lung cancer.

The Veterans Administration, Winston Salem, North Carolina is currently compiling all my service and medical records for re-evaluation.

If the House Subcommittee should need additional information, please feel free to contact me.

Again, thank you for your concern in this matter.

Sincerely,

ROY D. HUFFSTETLER.

Mr. CARTER. Thank you, Mr. Chairman.

Mr. ROGERS. Thank you.

Our first witnesses this morning will be a distinguished group of former military men who participated in nuclear tests in the 1950's. As Dr. Carter has mentioned, we are deeply indebted to the Disabled American Veterans organization for its efforts on behalf of veterans who were present at Smoky and other tests, and who subsequently have become ill. The members of this panel would not be here this morning if the DAV had not arranged for and absorbed the costs for each of these gentlemen's trips to Washington. So, the committee is grateful and we wanted to express it publicly to the DAV for their assistance.

Also, I believe, there is a letter that I would like to make part of the record, without objection, from the Disabled American Veterans organization.

[The following information was submitted for the record:]

DAV

Motto: "If I cannot speak good of my comrade, I will not speak ill of him."

DISABLED AMERICAN VETERANS

NATIONAL SERVICE and LEGISLATIVE HEADQUARTERS
807 MAINE AVENUE, S.W.
WASHINGTON, D.C. 20024
(202) 554-3501

January 13, 1978

The Honorable Paul G. Rogers, Chairman
Subcommittee on Health & the Environment
2407 Rayburn House Office Building
Washington, D. C. 20515

Dear Congressman Rogers:

I am pleased to submit for the record the following information with respect to the activities of the Disabled American Veterans as to assistance to veterans and their dependents who claim disability or death benefits resulting from radiation exposure.

Enclosed are copies of articles which appeared in the DAV Monthly Magazine in July and September of 1977, my memorandum to all Supervisory National Service Officers and letters from individual veteran or dependent claimants. We have available additional correspondence regarding allegations of radiation exposure prior to the 1950's and will make them available, if necessary.

Our 280 National Service Officers all of whom are accredited by the Veterans Administration to prepare, present and prosecute claims before that agency with respect to individual claimants who designate the Disabled American Veterans as their power of attorney, are all service connected disabled veterans themselves and more than 80% of them are Vietnam Era disabled. Our NSOs are stationed in every VA Regional Office and Center and in some VA Hospitals. They represent disabled veterans and their dependents without charge in an attorney-in-fact capacity to obtain from the Veterans Administration, the Social Security Administration and any other governmental agency all benefits to which the disabled veteran or his dependent may establish eligibility. In this regard, DAV NSOs are trying to help victims of radiation exposure or their widows in the ~~development of~~ necessary evidence to prove claims, in the expert ~~and~~

National Service Officers

professional presentation of such claims before local Rating Boards of the Veterans Administration, and, if necessary, in a request for Administrative Review by VA Central Office in Washington, D. C. or in reference to an appeal to the VA Board of Veterans Appeals.

Contact has also been made by the undersigned with Dr. Glyn Caldwell of the Center for Disease Control in Atlanta, Georgia. As you undoubtedly know, Dr. Caldwell is leading a study to determine among other things if the incidence of cancer is higher on average for those exposed to radiation in Nevada in the 1950's as compared with the general population. Copies of correspondence from individual claimants have been sent to Dr. Caldwell to assist him in his study.

I hope that the information presented herewith and the correspondence enclosed will prove of assistance to the Subcommittee. If additional information is necessary you may be assured of the continuing cooperation of the Disabled American Veterans.

Sincerely,

NORMAN B. HARTNETT
National Service Director

NBH:amh

cc: Dr. Caldwell
Enclosures

Mr. **Rogers**. The first witnesses will be Mr. Russell Jack Dann, from Albert Lee, Minn. Would it be convenient to come around to the table to a mike, if someone could perhaps help you, Mr. Dann; perhaps we could move those chairs.

Lt. Col. Frank W. Keating (ret.), from Tacoma, Wash.; and Col. Thomas Stedman (ret.) from Savannah, Ga.

I wonder if William E. Dennan, Dr. Dennan is present. He was not sure whether he could be here this morning.

All right, we welcome you, gentlemen; we are grateful to you for taking the time, and the DAV for helping this. I think you may proceed as you desire. Your statements will be made a part of the record in full without objection. We will turn it over to you and let you make your statements as you desire.

Mr. Dann, would you like to begin?

STATEMENTS OF RUSSELL JACK DANN, ALBERTA LEE, MINN.; LT. COL. FRANK W. KEATING (RET.), TACOMA, WASH.; LT. COL. THOMAS M. STEDMAN (RET.), SAVANNAH, GA.; AND HUBERT SMITH, ASHEVILLE, N.C.

Mr. **Dann**. Yes, Mr. Chairman.

Mr. **Rogers**. If you could speak as loudly as possible into the mike.

Mr. **Dann**. Can you hear me now?

Mr. **Rogers**. Yes, now.

Mr. **Dann**. To all interested personnel. Subject: Atomic bomb test August 31, 1957; called Smoky, Nevada, Yucca Flats. Please note, to the best of my knowledge this résumé contains no secret information, or any top-secret data pertaining to Shot Smoky. Any and all information is to the best of my recollection. Exact yardage, footage, height, location, number of personnel, and magnitude were never clearly explained to our echelon. My explanations are approximate.

To whom it may concern.

My status at the time of Shot Smoky was Cpl. Russell Jack Dann, RA-17424897. I was assigned to Company A, 505th Airborne Infantry Regiment, 82d Airborne Division, Fort Bragg, N.C. Date of birth, October 11, 1936. Social Security No. 48-538-3344; MOS 31177, communications chief. Dates of service, November 1954 to February 1958. Honorable discharge.

Five months before my ETS I was assigned to the 1st Training Command, 505th Airborne Infantry Regiment. First Lieutenant Ginn was my company commander, and he was also my platoon leader at Camp Desert Rock. I understand that no one has gotten a hold of him yet, Lieutenant Ginn.

Mr. Rogers. Excuse me, do you know where Lieutenant Ginn is located at this time, by chance?

Mr. Dann. That I know of, to my knowledge he has not been located.

Mr. Rogers. Thank you.

Mr. Dann. But he was my platoon leader out there.

My entire career of duty was as a training cadre, in a training company. The reason we were selected for Smoky was simple, they wanted NCO's with secret clearances. My MOS required a secret clearance, and I was the only one out of our company that was available. We were low on personnel, in other words.

A company of troops were formed, mostly NCO's within the 82d Airborne Division. On August 12, 1957, the entire company left Pope Air Force Base at Fort Bragg, N.C., aboard a C-124 Flying Globe Master. We arrived at Indian Springs Air Force Base the same day, which is between Las Vegas and Camp Desert Rock.

We were then transported to Camp Desert Rock, Nev. The days and the weeks that followed consisted mostly of critiques, some movies of other shots, proper protection from radiation, and survival. Other days we would low-crawl under approximately 30 yards of barbed wire. Other days we would crawl under this wire, and after the crawl we would then spread out a poncho, field-strip our M-1 rifles, reassemble them, semi-late lock and load, and fire. We were also timed on this. We were told we were to do this just before the shot and just after. The latter was never executed because of the radiation factor involved in Smoky.

It was believed that Smoky was a 44 KT bomb, to be located on a tower approximately 750 to 1,250 feet above the desert basin. We were never told exactly how high that tower was.

We were to be located in trenches approximately 3,000 yards south of Ground Zero. However, on the early morning of August 31, 1957, we were trucked into position and awaiting the shot. The tower was lit up like a Christmas tree. Floodlights made it very visible in the early morning hours. I could see an elevator going up to topside. It was clearly evident that the shot had the green light.

We went through mock procedures of kneeling in the trenches, holding our rifles and shielding our eyes with our right forearm. It seemed that within minutes we were told to load up again, that an alternate site had been chosen, and we would observe the shot. Loading back into the 5-ton Army open cattle trucks, we were then moved to a hillside east of Ground Zero, approximately the same distance as the trenches. We were then told that the wind may be a factor because of the fallout, and the trenches could be unsafe.

Pandemonium seemed to have struck most troops because there was no doubt in anyone's mind that this open-ground procedure, what it would result in. The troops were told to disperse and a chain of command issued proper exposure procedures. The result of the trench practice was reapplied here, also.

Communications had set up a PA system for the benefit of hearing the countdown. This location was completely contrary to the message that had been applied. Had it been an actual combat situation with anticipation of a shot, uniform of the day was a class D field jacket, pistol belt, first-aid packet, canteen, and poncho. Had this uniform included an entrenching tool, we could very well have dug in, or moved to the rear slope. It was as if observation was more important than safety.

No one found any humor in what was about to happen. The countdown toward "H" hour continued. As the last seconds ticked away there was a sizzling flash. I could see the bones in my arm, and within a few seconds the blast from the shock hit us.

It knocked me—and several other troops—10 or 15 feet. It blew my steel pot completely off—I never did find it. There was a devastating blast that words can never explain. After the shot our company paratroopers loaded back into the vehicles and moved down to within approximately 300 yards from Ground Zero. This was to monitor the tower to see what shape the tower was in, and it was nothing but a pile of rubble.

We also saw that the trenches that we were to have been in had caved in—they had caved in.

Before loading we were checked for radiation. My count was very high. I was required to remove my fatigue jacket and shake it out. A whisk broom was used on my jump boots. We all wore film badges, and some were lost and others were light-struck so that they actually fell open.

I also observed Shot Galileo, a low-yield bomb of approximately 12 KT. And then, again, we were on open ground. Some personnel field-stripped their weapons and reassembled them. I can never remember doing this. It was in the very early morning hours and visibility was not that good. I might add that the small shot had heat thermos that were very high.

Shortly after my discharge, February 28, 1958, and for several years to come I experienced serious dizziness. I lost my hair in blotches. The hair grew back in 6 to 8 months. It grew back gray very finely, and then it came back totally. My teeth began falling out, and I lost hearing in my left ear. 1961 revealed that the reason my wife and I were having no children was because of a very low sperm count. In 1963 I had trouble with my bones in my knees, I had water on the joints, troubled with both shoulders, and a local doctor treated me for bursitis. I had trouble with my fingers, and also with my wrist.

For years I have told my wife that these symptoms were a result of Shot Smoky—but who would ever believe such a Buck Rogers story? It was not until we have seen it on national TV and read it in several newspapers that I finally decided that now maybe someone will listen to our story of Smoky and decide it worthy of an investigation. Also, that such a guinea pig operation should never have existed.

The Army never attempted to contact me if any ill effects had resulted from Shot Smoky or Shot Galileo. I walked out onto the sun deck of my apartment in July of 1974, lit up a cigarette, leaned against the railing, and fell off backwards and busted my neck.

The doctors have treated me at Wood VA at Wood, Wis., near Milwaukee. I was in the hospital nearly a year and they told my wife—not me—that I had a weird blood cell count of some type, or possibly my liver. The results I have never known. But if they had known of Smoky, maybe it would have been different.

I have to go back in March for my yearly checkup and hope to find out more at that time. I thank you, Mr. Chairman.

Mr. ROGERS. Thank you very much for your statement. The committee will follow your case very carefully——

Mr. DANN. I am sorry, sir; I am awfully hard of hearing.

Mr. ROGERS. I said the committee will follow your case very carefully when you go back to the VA. So, we will be in close contact.

Colonel Keating?

STATEMENT OF LT. COL. FRANK W. KEATING (RET.)

Colonel KEATING. Can you hear me?

Mr. ROGERS. I think you have to get rather close to the mike, the mikes are not too clear.

Colonel KEATING. Now, can you hear me all right?

Mr. ROGERS. Yes; thank you.

Colonel KEATING. Mr. Chairman, I was the commanding officer of the 12th Battle Group of the 4th Infantry Division, which sent troops to Desert Rock.

The statement I am going to make, there is no information that I am aware that is classified, either.

The following information concerning my participation in Desert Rock in the infantry troop test exercise, Desert Rock VII and VIII, conducted at Yucca Flats, Nev., is furnished primarily from memory because I have no records of the test.

I was the commanding officer of the battle group from its activation in March of 1957 until September 1957, at which time I transferred.

Mr. ROGERS. Excuse me a moment, is the microphone turned on here?

Colonel KEATING. I don't know. Now you can get it.

Mr. ROGERS. Fine.

Colonel KEATING. I was the commanding officer of the 12th Infantry from its activation in March until September of 1957, when I transferred my command to a Colonel Redfield. During the period

I was in command, between 600 and 700 personnel in the unit did participate in Operation Smoky at Desert Rock.

As I recall, the initial date set for Operation Smoky was August 15, 1957. However, when we arrived at Camp Desert Rock, Nev., on or about August 1, we were notified that there were seven shots to be fired prior to the detonation of Smoky; and it may be delayed to a later date because of atmospheric condition, which does delay those shots.

We were undergoing a special training program in preparation for our participation in this operation, which training included personnel from the 12th Infantry, a platoon of the Queen's Own Rifles of Canada, and the 85th Aviation Battalion, Provisional, from Fort Bragg, N.C., commanded by a Lt. Col. Charles Ernest, which furnished helicopter support to the operation.

The training unit was a heavily reenforced pentomic unit which was designated Task Force Warrior, and was under the command of Capt. George D. Pebbles, the company commander of the 1st Battle Group, 12th Infantry. These troops were utilized to participate in each of the seven shots. During the participation in those shots the troops were placed in predug trenches at various distances from Ground Zero, the nearest position being approximately 4,500 yards from Ground Zero, which is about 2½ miles.

We did no tactical maneuvering with regard to these shots. If the shot was fired we waited until the AEC personnel swept the area and advised us that it was safe to move out; and we would load back into our trucks and go back to Camp Desert Rock. If the shot were not fired, we would load into our trucks and move across Yucca Flats to a training area where we were conducting training for this pentomic operation we were to participate in.

As best as I recall these shots were fired between 0300 and 0400 hours in the morning, and this was just at daybreak, so that they could pick up the clouds from the shot.

The commanding officer at Desert Rock was responsible for the movement of troops for Desert Rock to Yucca Flats. We were loaded into large transport trucks where each man's name was checked against a roster; and upon loading was a further check to determine that he had his radiation badge. Upon returning from Yucca Flats all troops were again checked by roster to determine that all personnel had cleared the area.

On the day Operation Smoky took place—I understand it was on August 31—we were transported to the test area in the same manner as on all previous occasions. The troops were moved into predesignated areas. These areas were approximately 8,500 yards—5 miles—from Ground Zero. After the shot upon notification that the area was safe and clear from contamination by AEC personnel, they would in accordance with tactical plans be transported by helicopter to the assault positions where at that time we went into the operation of capturing our objective.

It is my opinion that the safeguards and precautions imposed by the Atomic Energy Commission personnel appeared to be adequate to insure safety of all personnel; and to the best of my knowledge none of the individuals who participated in the test from my unit received an overdose of radiation.

However, this does not mean that an individual could not have received an overdose of radiation.

Thank you, Mr. Chairman.

Mr. ROGERS. Thank you very much, Colonel Keating.

Colonel Stedman?

STATEMENT OF COL. THOMAS M. STEDMAN (RET.)

Colonel STEDMAN. At the outset of this statement, I feel I should point out that my recollections of many of the incidents have become somewhat hazy in the intervening years. I have verified the dates of the various flights from my pilot log book, however [see p. 149].

At the time of the Smoky atomic blast I was a member of the 31st Transportation Company. This was an Army aviation unit equipped with 21 H-34 helicopters. The unit was stationed at Fort Benning, Ga.

On July 22, 1957, the helicopters began the cross-country flight to Camp Desert Rock, Nev. As I recall, the flight was expected to require 4 to 5 days. Due to many unexpected aircraft maintenance problems and shortages of aircraft spare parts, the helicopters straggled into Desert Rock about 2 weeks later than expected. My own helicopter was grounded at El Paso, Tex., for spare parts until August 14, and my copilot, the crew chief and myself remained with the aircraft. On August 14 the parts were received and installed, and on August 15 we departed for Camp Desert Rock, arriving on August 16.

On August 20 I made a familiarization flight with another pilot who had arrived earlier at the testsite. I flew missions through the test area on August 21 and 22 with Capt. John Dancey, a Canadian Army pilot who was attached to our unit, and on August 22 we flew a party of Canadian Army observers through the test area. I believe all the flights were made at low altitudes, probably 100 to 200 feet above the desert floor. On several occasions we flew over the sites of previous nuclear blasts. These blasts had been detonated from the tops of steel latticework towers and we could see the remnants of the towers flattened on the desert floor. I do not recall any restrictions against flying over, or near these sites. I am positive we would not have flown any closer than was done if these areas had been considered "hot."

On the late afternoon of August 30 our helicopter company flew out to be in place for the Smoky detonation, scheduled for before sunrise on August 31. Our company helicopters parked on a level area with the hill mass of News Nob directly between us and point of detonation. I believe News Nob was about a mile away, to the north of our location. I do not recall if the other helicopter unit in the exercise, which was the 8th Transportation Company from Fort Bragg, N.C., spent the night at the same location. I am quite sure that the troops in the foxholes were not in our area.

I believe the blast went off at least an hour before sunrise, since the sky was still dark. We waited in place until after sunrise to begin our part of the exercise. We were to ferry the troops from one part of the exercise area to another part. I cannot recall if we physically landed in the area where the troops were in foxholes during the blast. On this day, August 31, I flew a total of 3 hours and 20 minutes, which was probably typical of all other helicopters in our unit. I recall that the entire exercise area was covered with a heavy dust cloud, caused by the blast effect of the bomb. This dust cloud extended from ground level up to a height of several thousand feet, as I recall. Low visibility at the level that we flew—probably not more than 200 feet above the desert floor—made navigation difficult and we were always concerned about midair collisions with other aircraft which might be in the area. I believe the dust remained in the area throughout the entire day. I am quite certain that our flights were planned to avoid the point of detonation.

All the flight crews wore radiation measuring devices after arrival at Camp Desert Rock. I believe these devices were film badges. As I recall, these were checked periodically to determine if anyone had accumulated excessive radiation. I do not believe that anyone in the unit accumulated more than was considered safe by current standards. The helicopters were also checked for radioactivity. I recall that the crew chief told me that our helicopter was hotter than any other in the unit, although still safe. The crew chief also commented that the detection personnel found the highest levels of radiation on the helicopter were in the porous, rubber-like sponges which were fastened to the landing gear struts to act as bumpers for the engine access doors.

On September 1 the helicopters of our unit left Camp Desert Rock for maintenance at Ontario, Calif. and the ultimate flight back to Fort Benning, Ga.

I do not believe that gas masks were worn in our unit at any time during the exercise. I do know that the list of required clothing and equipment does not include gas masks.

I might point out that last year I had two small localized skin cancers removed, one from my forehead and one from my back. My wife and I have had no children since the atomic tests, and I jokingly said for years that probably I was radioactive from the atomic blast. I have not had any medical checkup on that aspect.

That concludes my statement. I would be pleased to comment.

[Testimony resumes on p. 159.]

[Attachments to Colonel Stedman's prepared statement follow:]

PILOT LOG BOOK

DATE	AIRCRAFT FLOWN: MAKE OF AIRCRAFT	CLASS	TYPE	CERTIFICATE NUMBER	MAKE OF ENGINE	H.P.	REMARKS OR INSPECTOR'S SIGNATURE CERTIFICATION NUMBER AND RATING	CROSS COUNTRY: FROM	TO	TIME: INSTRUMENT RADIO OR HOOD		DUAL: AS INSTRUCTOR		DUAL: AS STUDENT		SOLO: DAY		SOLO: NIGHT		DAILY TOTAL TIME
20 AUG 57	SIKORSKY	HEL	H-34	ARMY-906	WRIGHT	1525	AREA FAMILIARIZATION W/ JONES	DRA	LCL							01	15			01.15
21 AUG 57	"	"	"	ARMY-532	WRIGHT	1525	" " W/ CAPT DANCEY	"	"					CP 01	00	01	00			02:00
22 AUG 57	"	"	"	" "	"	"	FLYING W/ CAPT DANCEY + CANADIANS	"	"					CP 01	15	01	15			02:30
29 AUG 57	"	"	"	" "	"	"	FLIGHT TO LAS VEGAS W/ CAPT EVANS	"	"					CP 00	50	00	50			01:40
30 AUG 57	"	"	"	"	"	"	FLIGHT TO NEWS HQ W/ CAPT DANCEY	"	"					IP 00	15	00	15			00:30
31 AUG 57	"	"	"	" "	" "	"	FLIGHTS FOR EXERCISE "SMOKY"	"	"					IP 01	40	01	40			03:20
1 SEP 57	"	"	"	" "	"	"	FLIGHT FROM DRA TO ONTARIO W/ CAPT FITZ	"	ONTARIO CAL.					IP 01	15	01	15			02:30
6 SEP 57	"	"	"	" "	"	"	FROM ONTARIO TO PALM SPRINGS TO PHOENIX	ONTARIO CAL.	PHOENIX, ARIZ					CP 00	25	03	10			03:35
8 SEP 57	"	"	"	" "	"	"	FROM PHOENIX TO EL PASO, TEX.	PHOENIX	EL PASO					CP 02	00	02	00			04:00
10 SEP 57	"	"	"	" "	"	"	FROM ELP TO LOVE FIELD, DALLAS	ELP	DAL							05	40			05:40
11 SEP 57								DAL	JAN							04	10			04:10
									TOTAL			68	40			22	30			31:10
									AMT. FORWARD	68	45	66	55	201	50	1044	15	69	15	1453:00
									TOTAL TO DATE	68	45	75	35	201	50	1068	45	69	15	1484:10

I HEREBY CERTIFY THAT THE FOREGOING ENTRIES ARE TRUE AND CORRECT.

SIGNED

COPY No 16
3d Trans Bn (Hoptr)(Army)
Fort Benning, Georgia
151200 July 1957

OpnO 1
Map: Sectional Charts 1:500,000, Birmingham, Shreveport, Dallas, Austin, Roswell, El Paso, Douglas, Phoenix, San Diego, Los Angeles, Mt. Whitney

Task Orgn:

Advance Party (Annex D)
Hq & Hq Det 3d Trans Bn (Hoptr)(Army)(-)
31st Trans Co (Lt Hoptr)(H-34)(-)
138th Trans Det (CHFM)

Organic Aircraft Group (Annex E)
31st Trans Co (Lt Hoptr)(H-34) (Annex G) (Classified - Not Enclosed)

Main Body
Hq & Hq Det 3d Trans Bn (Hoptr)(Army)
31st Trans Co (Lt Hoptr)(H-34)(-) (Annex F)

1. SITUATION.

a. Hq & Hq Det, 3d Trans Bn (Hoptr)(Army), 31st Trans Co (Lt Hoptr)(H-34) and 138th Trans Det (CHFM) have been ordered to proceed from Ft Benning, Georgia to Camp Desert Rock, Nev.

b. 31st Trans Co (Lt Hoptr)(H-34) and 138th Trans Det (CHFM) are attached to 3d Trans Bn (Hoptr)(Army).

c. The 3d Trans Bn (Hoptr)(Army) upon arrival Camp Desert Rock, Nev. will be redesignated the 85th Army Avn Bn (Prov).

2. MISSION.

a. The 3d Trans Bn (Hoptr)(Army) displaces to Camp Desert Rock, Nev. commencing 18 July 1957, and prepares to participate in Exercise Desert Rock VII and VIII not later than 27 July 1957.

b. Upon arrival the 3d Trans Bn (Hoptr)(Army) conducts advance unit and individual training of organic personnel and helicopter operations training for Infantry Battle Group Personnel.

3. EXECUTION. Concept of Opn. The movement will be conducted in three phases.

a. The advance party consisting of liaison personnel of the 3d Trans Bn (Hoptr)(Army) and 31st Trans Co (Lt Hoptr)(H-34), all assigned mess personnel and the 138th Trans Det (CHFM) with 127,000 lbs of vehicular equipment and aircraft component and spare parts will depart Lawson Army Air Field on 18 July 1957 via Air Force Aircraft. Aircraft to be spotted Lawson Army Air Field 1500 EST 17 July 1957. Point of Arrival to be Indian Springs Air Force Base, Nev. (Annex D)(Advance Party)

b. The organic Aircraft group consisting of 21 H-34A helicopters and crews of the 31st Trans Co (Lt Hoptr)(H-34) depart Fort Benning, Georgia on 22 July 1957. (Annex E) (Organic Aircraft Group) Route of flight will be determined by C.O., 31st Trans Co (Lt Hoptr)(H-34)

c. The main body consisting of the Command and Control group, 3d Trans Bn (Hoptr)(Army), the 31st Trans Co (Lt Hoptr)(H-34) less helicopter crews and 3000 lbs of TO&E equipment will depart Lawson Army Air Field 25 July 1957. Point of Arrival to be Indian Springs Air Force Base, Nev. (Annex F) (Main Body)

Par 4, OpnO 1, Headquarters 3d Trans Bn (Hoptr)(Army). 15 July 1957

4. ADMINISTRATION AND LOGISTICS. Annex C. Administrative Instructions.

5. COMMAND AND SIGNAL.

a. Signal - Organic Aircraft group - RFC

b. Command

Hq 3d Trans Bn (Hoptr)(Army) - Opens Camp Desert Rock 20 July 1957.

31st Trans Co (Lt Hoptr)(H-34) Organic Aircraft Group - Unit Commander

Hq 3d Trans Bn (Hoptr)(Army) - Main Body - Close out Fort Benning, Georgia, 25 July 1957

ERNEST
Lt Col

Annexes: A - Movement Order # 1, LAAFC dtd 15 July 1957.
B - Air Route Overlay (Omitted)
C - Administrative Instructions
D - Advance Party
E - Organic Aircraft Group
F - Main Body
G - Classified (Not Enclosed)

OFFICIAL:

Fitzgerald
FITZGERALD
S-3

HEADQUARTERS LAWSON ARMY AIR FIELD COMMAND
Fort Benning, Georgia

MOVEMENT ORDERS
NUMBER 1

15 July 1957

1. In compliance with movement directive, Headquarters United States Army Infantry Center, Fort Benning, Georgia, GFKEC-O 370.5, subject; "Movement of Units for Temporary duty", dated 9 July 1957, the following units of this Command will move to Camp Desert Rock, Nevada, so as to arrive thereat NLT 27 July 1957:

a. Hq & Hq Detachment, 3rd Transportation Battalion.

b. 31st Transportation Company (Lt Hcptr)(H-34).

c. 136th Transportation Detachment (CHFM)

2. This is a temporary change of station for approximately forty-eight (48) days. Upon completion of mission as directed by Commanding General, Sixth US Army, personnel and equipment will return to home station.

3. Personnel and Equipment:

a. Personnel will remain as presently assigned and on arrival at destination are attached to Sixth US Army to be further attached as directed by Commanding General, Sixth US Army for duration of TDY.

b. Clothing and equipment necessary to accomplish mission is authorized. Health Records (DD Form 722) of personnel concerned will be maintained in the personnel section during period of TDY.

4. Movement Data:

a. Movement will be made by Military Air and organic transportation.

b. TPA is not authorized. Travel is group travel as defined in paragraph 4201.10, Joint Travel Regulations, except as applies to crews piloting aircraft in connection with this move.

c. Dependents will not accompany troops.

d. Necessary POL products will be furnished from Government Stocks. The Quartermaster, this station will furnish courtesy cards to be used for emergency road repairs only.

e. Details of movement will be governed by the applicable provisions of SR 55-130-45; SR 57-5-1 as amended; Circular Number 1, Headquarters Third US Army, 2 January 1957; Letter AJMTV 510 General, Headquarters Third Army, 24 April 1956, subject "Instructions Governing Domestic Troop Movements."

(Cont'd Movement Orders No. 1 cs this Hq dtd 15 Jul 57)

f. Necessary action will be taken by this Headquarters to comply with SR 55-720-2, including reports required by paragraph 13 thereof.

5. Fiscal Data:

a. All duty performed under this directive is field duty of a type as contemplated by paragraph 4201.6 Joint Travel Regulations, TDN. In emergency only obligate funds in accordance with current fiscal procedures.

b. Costs incident to movement are chargeable to fund account number 2182020 856-1533 P2000-02-03-04-07-08 (2010.2)S09-038 (DESERT ROCK) GKXEC-0-1. Copies of all obligating documents (sales slips, issue slips, etc.) will be annotated "DESERT ROCK" and mailed immediately to Commanding General, United States Army Infantry Center, (Attention: Assistant Chief of Staff, G3).

c. A Class "A" agent officer will be appointed by this Headquarters in accordance with AR 37-103, to account for necessary cash expenditures during movement.

6. Detailed Instructions:

a. Authority: Message AJPOD 6-25-0, Headquarters Third US Army 3 July 1957.

b. Billeting and messing facilities are available at destination.

c. Direct communication is authorized to coordinate details of movement.

d. Advanced parties authorized.

e. All operations orders issued under this movement order for participating troops will include the following:

(1) Security clearance for each individual.

(2) A Statement that the individual is a US Citizen.

(3) A Statement that cameras are not permitted in the Desert Rock Area.

(4) A summary of pre-exercise training that the individual has received.

f. The S-2 officer, 3rd Transportation Battalion, will prepare in triplicate, rosters indicating individual clearance of all listed unit personnel, and accompanying personnel, if any. All officers and Warrant Officers will possess at least, an interim secret clearance, and rosters will denote degree of clearance, date of clearance and headquarters granting clearance. Two (2) copies will be furnished the S2, Camp Desert Rock, by

(Cont'd Movement Orders No. 1 cs this Hq dtd 15 Jul 57)

the unit commander immediately upon arrival at Camp Desert Rock, and one (1) copy will be retained by the Unit.

g. Record of Emergency Data for the Armed Forces of the United States, DD Form 93, for each member of participating units will accompany units to the maneuver site, and remain in custody of the personnel officer during period of TDY.

h. Purpose: To participate in exercise DESERT ROCK VII and VIII during period of 20 July -30 August 1957.

FOR THE COMMANDER:

OFFICIAL:

Rex K. Chambers
REX K CHAMBERS
WO W1, USA
Asst Adjutant

PATRICK J O'GRADY
1st Lt., Infantry
Adjutant

DISTRIBUTION:
SO Special Distribution:
5 - CO, LAAPC
100 - CO, 3d Trans Bn (Hcptr)(A)
300 - CO, 31st Trans Co (Lt Hcptr)(H-34)
100 - CO, 136th Trans Det (CHFM)

Information copies to:
TAG, Wash 25, DC - 40 copies
CG, CONARC, Ft Monroe, Va - 5 copies
CG, 3rd Army, Ft McPherson, Ga (ATTN: AJPCD) - 5 copies
CG, 6th Army, Presidio of San Francisco, San Francisco, Calif - 10 copies
CO, Camp Desert Rock, Las Vegas, Nevada - 10 copies
CG, USAIC, Ft Benning, Ga - 19 copies

ANNEX "C" (Administrative Instructions) to Operations Order #1, Headquarters 3d Transportation Battalion (Hoptr)(Army)

1. Logistics:

a. Clothing and individual equipment necessary to accomplish mission will be carried by each individual. (See appendixes 1 & 2, Annex "C").

b. In compliance with the request of Test Director, Desert Rock, and commensurate with availability of items thereat, only those items of TO&E equipment essential to the accomplishment of the mission will be taken. Equipment left at Fort Benning will be secured and maintained by a rear detachment.

c. Only that Post, Camp and Station property authorized by letter GNKED (25 June 1957) US Army Infantry Center, Fort Benning, Georgia will be taken.

d. A Consolidated Battalion Mess will be established by Headquarters 3d Transportation Battalion (Hoptr)(Army). All mess personnel assigned to attached units will be placed on Special Duty to Headquarters & Headquarters Detachment, 3d Transportation Battalion (Hoptr)(Army) commencing 15 July 1957 for the duration of the exercise. The Battalion Mess Officer will be responsible for the procurring of necessary kitchen equipment to feed approximately four hundred (400) personnel.

e. A thirty (30) day supply of Office expendables will be taken by each section and unit.

f. A fourteen (14) day level of janitorial and cleaning supplies will be taken by each unit.

2. Administration:

a. The uniform for all personnel enroute to Desert Rock and during their stay at Desert Rock is as follows unless otherwise directed:

(1) Fatigue Uniform *

(2) Boots (with trousers bloused)

(3) Field cap with stiffener or locally purchased stiff cap

(4) Pistol belt with First Aid packet and pouch, canteen with cup and cover

* Fatigue uniform will have patches, name tapes and US Army tapes attached as per local uniform regulations.

b. A 3d Transportation Battalion (Hoptr)(Army) personnel section is activated. The personnel officer will be responsible to gather and transport to Desert Rock and maintain while thereat personnel records to include Service Records, DA Form 66 (Officer's Qualification Record), DA Form 20 (Enlisted Qualification Record), DD Form 113 (Military Pay Record), DD Form 722 (Health Record), DD Form 122 (Certificate for Aviation Pay), DD Form 93 (Record of Emergency Data), 201 File and all other related personnel records and forms of all personnel assigned or attached to 3d Transportation Battalion (Hoptr)(Army).

c. Morning Reports and recurring reports presently required will be processed in duplicate so that Desert Rock Headquarters will be informed and installation (Fort Benning) can be currently informed on all phases of operations.

ANNEX "C" (Administrative Instructions) to Operations Order #1, Headquarters 3d Transportation Battalion (Hoptr)(Army) (Cont'd)

d. The Commanding Officer of 31st Transportation Company (Lt Hoptr)(H-34) will designate a Class "A" agent officer in accordance with AR 37-103 to account for necessary cash expenditures during movement.

e. The Commanding Officer 31st Transportation Company (Lt Hoptr) (H-34) will appoint an officer to secure copies of all obligating documents (Sales slips, issue slips, etc.) which will be annotated "DESERT ROCK" and mailed immediately to Commanding General, US Army Infantry Center, Fort Benning, Georgia (ATTN: Assistant Chief of Staff, G3).

f. Medical evacuation enroute will be made to nearest Army, Navy, Air Force or other government hospital. Evacuation to civilian hospital will be made under the provisions of AR 40-505 and SR 40-505-11 and may be resorted to if life or limb is endangered.

g. The Commanding Officer of 31st Transportation Company (Lt Hoptr)(H-34) will designate a Claims Officer who will be responsible to make reports in writing of any incident which might result in a possible claim for or against the United States Government or which may be entered as evidence in connection therewith.

h. Cameras are not permitted in the Desert Rock area and will not be taken by participating personnel.

i. Pre-exercise training as directed by Exercise Director, Desert Rock VII & VIII, to include desert operations, desert health, hygiene and sanitation, and atomic effects has been conducted for all personnel listed in Annex D, E, and F, except as indicated thereon.

MINIMUM CLOTHING AND EQUIPMENT REQUIREMENTS
DESERT ROCK VII AND VIII

OFFICER

Following is a list of individual, organizational and miscellaneous items of clothing and equipment considered essential to operations at Camp Desert Rock. This list is not designed to stifle individual ingenuity as regards personal requirements or comfort but is minimum requirements. All personnel are encouraged, within reason, to take any item that will appreciably enhance the living and comfort factor while at Camp Desert Rock.

INDIVIDUAL CLOTHING AND EQUIPMENT

	Quantity Required
Boots, service combat	2 pr
Cap, garrison shade 44	1
*Cap, service shade 44	Optional
Cap, utility (blocked)	1
Fatigues with Follow Me patch, company patch, name tape, US Army tape	5 sets minimum
Shirt and trousers, cotton khaki	2 sets
Shirt and trousers, TW	Optional
*Uniform TW with blouse	Optional
Baseball cap	1
Shoes, low quarter	1 pr
Identification tags, with chain	1

*Required by all commissioned officers

ORGANIZATIONAL EQUIPMENT

Poncho	1
Bag, sleeping with air mattress and cover	1
Belt, pistol	1
Canteen with cup and cover	1
First aid pouch with packet	1
Flight suit	1 minimum
Flight jacket	1
Sun glasses	1 pr
Gloves, flying	1 pr
Headset	1
E6B	1
Sheets	4
Pillow cases	2
Pillow	1
Blankets	3

MISCELLANEOUS

Bag, duffel	Optional
Foot locker	Optional
Hand bag	Optional
Civilian clothing	Optional(recommend)
Folding chair, lt wt	Optional

Appendix 1 to Annex C, Operations Order #1, Headquarters 3d Transportation Battalion (Hcptr)(Army)

NOTE: NO GAS MASK
(ADDED 1-18-78)

MINIMUM CLOTHING AND EQUIPMENT REQUIREMENTS
DESERT ROCK VII & VIII

ENLISTED

Following is a list of individual, organizational and miscellaneous items of clothing and equipment considered essential to operations at Camp Desert Rock. This list is not designed to stifle individual ingenuity as regards personal requirements or comfort but is minimum requirements. All personnel are encouraged, within reason, to take any item that will appreciably enhance the living and comfort factor while at Camp Desert Rock.

INDIVIDUAL CLOTHING

	Quantity Required
Belt, waist web w/brass buckle	1
Boots, service, combat	2 pr
Cap, garrison, khaki	2
Cap, utility, blocked (fatigue)	1
Shorts, cotton	all
Undershirt, cotton, T	all
Jacket, utility (fatigue) with Follow Me and Company patch	all
Trousers, utility (fatigue)	all
Shirt, cotton, khaki	2
Trousers, cotton, khaki	2
Necktie	1
Shoes, low quarter	1 pr
Socks, cotton	all
Socks, wool	all
Jacket, field with Company patch	1
Bag, duffel	1
Identification	1

ORGANIZATION CLOTHING AND EQUIPMENT

Gloves, work leather	1 pr
Poncho	1
Bag, sleeping with waterproof case and air mattress	1
Belt, pistol	1
Blanket, wool	3
Mess gear, complete	1
Canteen with cup and cover	1
Pocket, magazine carbine	1
Pouch, first aid with packet	1

POST CAMP AND STATION EQUIPMENT

Sheets, cotton	4
Pillow	1
Pillow case	2

MISCELLANEOUS

Civilian clothing	Optional
Hand Bag	1

Appendix 2 to Annex C, Operations Order #1, Headquarters 3d Transportation Battalion (Hcptr)(Army)

Mr. ROGERS. Thank you, Colonel Stedman, for a helpful statement.

Also, we have Mr. Hubert Smith from North Carolina. We appreciate your being here, too. We would be pleased to hear your statement, if someone could give him the microphone.

STATEMENT OF HUBERT SMITH

Mr. SMITH. Thank you for the opportunity, Mr. Chairman. Can you hear me?

Mr. ROGERS. Yes. Keep the mike close to you, though.

Mr. SMITH. I guess I have the right one.

I came into this a little bit later. I have a statement here briefly describing my experiences during these tests. These were different, the tests that I was involved in were quite different from the ones they were talking about. I believe these other gentlement are talking about an Operation Plumbbob, which happened in 1957. I was involved before that time.

I am a retired Federal employee, I am 55 years old. I live in Asheville, N.C., and I retired from the Federal service with the Environmental Protection Agency in September of 1975.

In April 1977 I had a complaint, and I had a biopsy which revealed that I had prostate cancer. My doctor recommended surgical removal of the prostate gland but I searched for an alternate treatment because of the disability which results from that operation. My search led to the West Virginia University Medical Center at Morgantown, W.Va., where in June of 1977 Dr. Kandzari performed an operation to implant radioactive iodine—that is iodine-125—pellets in the gland around the tumor. A biopsy of the lymph nodes removed during the operation revealed that it spread to the lymph glands. This required further treatment, cobalt radiation, which I received in Asheville, N.C., at Mission Hospital. I have since recuperated and I feel pretty good at this time.

Because there is no history of cancer in my family, or any other apparent reason, I questioned whether or not it might have been caused by the latent effects of radiation received during nuclear weapons tests in 1953 and 1954. However, I must add that my doctors have told me that the cause of prostate cancer is not known, and that several possible causes are suspected.

In 1953, while serving on active duty as a captain in the U.S. Air Force I was assigned to duties at the Naval Ordnance Laboratory at White Oak, Md., to design, make and field test air blast instruments for use at the Nevada testsite. During the nuclear test operation at Upshot Knothole I and others of the party—both military and civilian—placed instruments in the proximity of the ground zero location for the detonations. We returned after the detonations while radio-activity was still present, but of course reduced, and at those times we were exposed to residual radiation. We did that for several tests, and I don't have records on how many times we did reenter—it was several.

Film badges were worn, but I do not recall knowing the amount of radiation received. It was generally thought to be within the then existing occupational standards.

Upon completion of the work at the Nevada testsite I returned to the Naval Ordnance Lab to prepare for the next test operation, which was to be held at the Enewetak testsite in the Marshall Islands. This work involved designing and building mechanical components and housings for underwater shock measurements during the upcoming high yield test. In February, 1954, I and others of the field party placed instruments in the Bikini Atoll Lagoon in preparation for the first detonation. We worked from a U.S. Navy salvage vessel, *Gypsy*. We also used a Navy fleet tug, but I cannot remember the name of that one.

For the test we departed from the lagoon and cruised around in the open ocean, which was about 35 miles from the site of the explosion. I witnessed the March 1, 1954 shot from aboard the *Gypsy*. Shortly after the shot our ship's radiation monitor noted a significant rise in radiation from fallout. The ship moved out of the area, but it was a very slow ship and large area, so, this took a long time; I don't really know how long.

Later—and I do not recall the exact time, I think about 2 days later—we returned to the lagoon to recover our instruments. These had to be recovered to get the data from the shot. But, as you might expect, they were displaced. We did find them, we searched the lagoon, and remained in the lagoon for some time. I cannot really give you any indication how long, but several days, probably. The radiation levels were fairly low, but they were measurable.

Now, aboard the ship we had a survey meter, as I recall. I did not have a film badge, and to my knowledge no one else had one. I do remember that the party discussed how much dose we received, and we kind of concluded that we may have received several roentgens for those first few days that we were exposed. I came and went from the Bikini area several times there, so, I could not even tell you how long I was there altogether. I left and did not return after the second shot of the series, but the *Gypsy* crew and the other crew did remain for some extended period after that.

After completing my work and writing the reports on this, I was reassigned to the Armed Forces Special Weapons Project Headquarters where I became a staff officer in the Radiation Branch, concerned with radiation matters.

In January of 1956 I left this to take a civilian position with the Atomic Energy Commission in the Weapons Division, and what happened after that has probably no relevance to this hearing.

I would like to add—it is not in my statement here—but these field reports were reported but they were classified when prepared. I do not know if they have been declassified yet or not. Anyway, the operations are described in those reports.

If the subcommittee has information suggesting abnormally high incidence of cancer developing among personnel who were present during or after nuclear tests, I should agree that a full investigation is justified. A large number of military and civilian personnel participated in these tests. Their collective medical history might yield valuable statistical information as to latent effects of radiation or cause of cancer. Of course, if a correlation is found, indemnification of the victims should be considered.

Thank you very much.

Mr. ROGERS. Thank you very much, Mr. Smith, for your presence and for your statement.

Dr. Carter?

Mr. CARTER. Thank you, Mr. Chairman.

Mr. Dann, what instructions were you given prior to Smoky and other tests you were in?

Mr. DANN. You are addressing me, sir?

Mr. CARTER. Yes, sir.

Mr. DANN. I am sorry, Mr. Carter, I could not hear you.

Mr. CARTER. I said, what instructions were you given prior to Smoky and other tests?

Mr. DANN. What instructions?

Mr. CARTER. Yes, sir. By your commanding officers.

Mr. DANN. By the commanding officer, whoever was involved?

Mr. CARTER. Yes, sir; the topkick usually gives them.

Mr. DANN. The morning of the shot, you are talking about. We went into position in the trenches. These trenches were the ones that we had used in mock procedures inasfar as getting away from the gamma rays of the shot itself, and the thermo. This was the reason that the trenches were located to close.

At that time the army was going through a reorganization, and the pentomic warfare seemed to be the thing. I believe that has since changed. But we were then asked, in the last few minutes—I would guess 45 minutes—to get out of the trenches because there was a danger factor involved that the cloud from the bomb, which rose to 60,000 to 70,000 feet, would possibly carry dust directly into our trenches, and not the magnitude of the shot. So, they immediately took us out, loaded us up, and took us over to a hill east of the tower. This is still in the early morning hours and we were on a downward slope, facing the shot. There was no high ground between us and Shot Smoky.

The orders that we received, Mr. Carter, were to disburse and to shield our eyes, get down on one knee and cradle our M-1 rifle, and use the same mock procedure that we had used in the trenches. That is all I can tell you about it, Mr. Carter.

Mr. CARTER. And at the time of the explosion you saw the bones in your arm; is that correct?

Mr. DANN. What was that, sir?

Mr. CARTER. At the time of the explosion you saw the bones in your fingers, or hands?

Mr. DANN. Yes, sir, I did. Yes, sir, I certainly did.

Mr. CARTER. How soon after the explosion were you ordered near ground zero?

Mr. DANN. As soon as the thermoheat hit us, and the shockwave, the blast had went over our heads, and the dust. Then the back pressure, or the vacuum from the blast and the dust settled and we got half organized, then we were moved off onto the hill.

There were 163 enlisted men or paratroopers, 7 officers. They were moved and loaded up into cattle trucks, taken down to where we were to be in trenches, and noticed that the trenches were all caved in. Then we walked to it, then, nearly 300 yards of ground zero.

Mr. CARTER. Was there a lot of dust there at that time?

Mr. DANN. The dust was high from there. No.

Mr. CARTER. There was no dust around you.

Mr. DANN. It was settled. The dust was up on the high ground. We marched and breathed the dust we created.

Mr. CARTER. In the pictures I have of Smoky I see that there is a lot of dust shown near the ground.

Mr. DANN. Sir, that even came out of my magazine, by the way.

Mr. CARTER. Sir?

Mr. DANN. That came out of my magazine.

Mr. CARTER. Oh, is that so.

Mr. DANN. The dust that is shown is what he is talking about when the helicopters come in later. The dust was very, very high there on the low ground.

Mr. CARTER. The helicopters would fan it up, of course.

Mr. DANN. Yes.

Mr. CARTER. You have been sterile since Smoky; is that correct? You have no children?

Mr. DANN. No, sir. I have been married 19 years.

Mr. CARTER. Thank you, sir. Colonel Stedman, you suffer from the same incapacity, is that correct? You have no children?

Colonel STEDMAN. None since the Smoky blast.

Mr. CARTER. Not since the Smoky blast. Previous to that you had children?

Colonel STEDMAN. Yes, sir.

Mr. CARTER. Mr. Smith, sir, I believe you stated you have cancer of the prostate. Your last exposure to atomic radiation was in 1954, is that correct?

Mr. SMITH. Yes, sir, that is correct—no, not quite, I forgot something. I did not put it in my statement, but I did make another trip to the Nevada test site in 1955, but I do not really think I had any exposure there, there might have been.

Mr. CARTER. Have you had any children since that time, have you sired any children?

Mr. SMITH. Yes, I have one fully grown and very normal.

Mr. CARTER. Colonel Keating, you were there on August 31, 1957. How near to the ground zero did you get after the blast?

Colonel KEATING. We went right in.

Mr. CARTER. Right in to where the blast was. Were you carried in by helicopter, or by truck?

Colonel KEATING. We were carried. The troops were 8,500 yards back, the ones that were ferried by the helicopters.

Mr. CARTER. Yes, sir.

Colonel KEATING. There was another group, that was the observers; we were at 4,500 yards. So, the troops were picked up by the helicopters and moved into predesignated assault areas, which were probably 3,000 yards or so from the ground zero. Then they started their movement in to attack their objective. The objectives were the hills and the materials that has been placed around the shot prior to its destination.

Mr. CARTER. How close did you get to the site of the tower?

Colonel KEATING. About 300 feet.

Mr. CARTER. About 300 feet. Was there much dust in the air at that time?

Colonel KEATING. Not at that time.

Mr. CARTER. Did I understand you to say that you did not go in by helicopter?

Colonel KEATING. Well, the helicopters made dust when they came in, and when they would go away it would settle. They would agitate it constantly.

Mr. CARTER. Yes, sir. How long after the blast was it that you went it?

Colonel KEATING. Well, timewise I do not recall, but everytime there was a blast the Atomic Energy people who had protective clothing on, and their equipment, would go out through the area and notify us that it was safe for us to go in.

Mr. CARTER. Yes.

Colonel KEATING. And that is when we moved.

Mr. CARTER. Since 1957, have you fathered children?

Colonel KEATING. No.

Mr. CARTER. Would you have like to have had children?

Colonel KEATING. I didn't want any more.

Mr. CARTER. You did not want any more?

Colonel KEATING. I had enough of them.

Mr. CARTER. That does not mean you could not have sired children?

Colonel KEATING. I think I could have, if I had wanted to. I do not have anything physically wrong.

Mr. CARTER. It would depend upon your sperm count, as I see it. Your health has been good since Smoky?

Colonel KEATING. Yes, sir. I just had a physical a month ago.

Mr. CARTER. You see, one of the dangerous things, as I see it, from the movement is the inhalation and ingestion of the dust, which contains alpha particles and other radioactive materials, which are not registered on your film badges but which get into your lungs. You breathe them in and some have a half-life of 200 years of course, you will not live that long, but even now if you breathed in these materials you might have a reaction to those internal emitters.

Mr. Dann, have you been diagnosed as having osteoporosis, softening of the bones, or not?

Mr. DANN. No, sir, Mr. Carter, I have trouble with the joints in my arms and legs. Bursitis arms.

Mr. CARTER. Thank you very kindly Mr. Dann. Thank you, Mr. Chairman.

Mr. ROGERS. Mr. Florio?

Mr. FLORIO. Gentlemen, than you very much for your very helpful coments. I would like to develop a point with regard to the adequacy of the badge monitoring process. Most of you have indicated that you had these badges, although at one point an individual said they did not have badges.

I am particularly interested, if the commissioned officers could indicate to me, what procedure you were instructed to follow concerning the collection of the badges. I am also interested in the recordkeeping instructions that you had so as to insure that the badges that were going to be forwarded for further processing would be on line with the appropriate individual. Were you given any instructions for the collection of badges?

Colonel KEATING. The badges had a number.

Mr. FLORIO. I am sorry.

Colonel KEATING. The badges had a number.

Mr. FLORIO. The badges had a number.

Colonel KEATING. And you assigned them to each individual?

Mr. FLORIO. I assume you are saying that the individual had a numbered badge assigned to him.

Colonel KEATING. It was issued to him with that number, and then those badges were periodically read to determine the density of radiation that he had received.

Mr. FLORIO. By whom were they read?

Colonel KEATING. By the Atomic Energy people.

Mr. FLORIO. It is my understanding that the badges could not be looked at and read on the spot, they had to be collected and processed.

Colonel KEATING. It was a little long badge with a slit in it with the film in it.

Mr. FLORIO. I assume the badges were collected, read, and then given back to the individuals; is that your understanding?

Colonel STEDMAN. That is how I recall it, I am not real clear on that point. As you say, it was nothing that the individual could look at and tell himself. It was read by other personnel, periodically.

Colonel KEATING. There was no change in the coloration of the badge so that you could ascertain whether or not you were getting an overdose. The badges were read by the AEC personnel.

Mr. FLORIO. So, in terms of multiple exposure, you would get a badge; it would be taken off some place, presumably read, and stored; and then a new badge would be issued.

Colonel KEATING. Well, either a new badge, or we got the same badges back.

Mr. SMITH. Mr. Florio, those are film badges similar to the type that radiologists still use. It requires the development of the film on their total dose-reading instruments. So, they would read all the dose that they were exposed to during the time they were out, up to development.

Mr. FLORIO. And were any of the individuals here informed as to the readings, or just told that they were OK? In other words, did the personnel get back reports that you were within acceptable limits, or you were not within acceptable limits. Does anyone recall getting back specific reports?

Colonel KEATING. We did not get any reports back to my knowledge that there were any that had adverse readings.

Mr. FLORIO. You therefore assumed that everything was OK when you did not get a report back.

Colonel KEATING. Yes.

Mr. FLORIO. Might I ask this gentleman who seems to be rather conversant with the process. It is my understanding that there is a process called solarization, which involves a higher level of dosage than what was expected to be attained. That is to say these badges were treated with the expectation that they would just have been exposed to low-level dosage. But there is also a question, if in fact a higher level of dosage is obtained, that if you test for the low levels of dosage, you may not get an adequate reading.

Does that mean anything to you?

Mr. SMITH. I believe what you are referring to is the range of the film badges, sir.

Mr. FLORIO. That is right.

Mr. SMITH. I do not know what was used in those tests specifically. Some of the exposure might have exceeded, conceivably could have exceeded the ranges of film badges, but I really would not think so.

Mr. FLORIO. You are saying, it is not probable.

Mr. SMITH. To my knowledge it is not probable, but again, I am not aware exactly of the nature of the film badges that were used on those particular occasions.

Mr. CARTER. If the gentleman would yield?

Mr. FLORIO. Certainly.

Mr. CARTER. The film badges at Smoky recorded only beta and gamma rays. They did not record alpha rays in the dust that the gentlemen would have breathed when they went in to the detonation area.

I thank the gentleman for yielding.

Mr. FLORIO. Thank you very much. That is all, Mr. Chairman.

Mr. ROGERS. Mr. Preyer?

Mr. PREYER. Thank you, Mr. Chairman, and I thank all of you for being here today.

I would like to ask Mr. Smith—welcome from North Carolina, Mr. Smith, incidentally—have you kept up with any members of the crew of the *Gypsy*? Have you had any ship reunion parties?

Mr. SMITH. No, sir, we have not. I was actually with a field test party, the *Gypsy* was our vehicle. It was, of course, all Navy personnel. I mentioned it because they were all exposed to it, the whole crew. If anyone wants to look up the records on that, they might find it in the ship's logs.

But, no, we have not had any reunion. Once or twice I have met with some of the people, just by coincidence, the people that were involved. But, no, there has been no reunion. I do not know what has happened to them.

Mr. PREYER. So, you are not familiar with the medical history of any members of the field group or the *Gypsy* group?

Mr. SMITH. No, sir.

Mr. PREYER. You mentioned some field reports that you said might still be classified. Are those reports just dealing with the nature of the operation, how you conducted the tests; or do they have anything about another goal?

Mr. SMITH. Well, this was some time ago and I do not remember exactly what we put in the reports. I think I wrote in my portion of the reports a description of the field exercise because it was pertinent to what we were doing. Our interest was measuring the blast pressure, in the first case the air blast; in the second case underwater shock pressures. Of course, that information was classified and may still be, I am just not familiar where it stands.

But we did write up something about the location and the recovery as of possible interest to someone that would be conducting future tests.

Mr. PREYER. Have you ever been contacted by anybody in the Government, or in any official way as a form of followup study as to what might have happened to your health?

Mr. SMITH. No, sir. My awareness and reason for being here was, I heard about it through the news media and understood they were looking for people. I suppose I might not have responded if I had not come up with the diagnosis that I got. But I thought it might be of interest. So, I put in a call to the committee about it.

Mr. PREYER. I was going to ask you how you happened to be here.

Mr. SMITH. Through the news media.

Mr. PREYER. It is a volunteer situation.

Mr. Dann, you mentioned there were 163 men and 7 officers in your group?

Mr. DANN. Yes, sir.

Mr. PREYER. Have you had any contact with them, or kept up with them through the years?

Mr. DANN. Only Mr. Cooper. I talked to him briefly on the telephone after I had seen his name in the paper, and he was very sick at the time.

Mr. PREYER. So, you have only kept up with that one man out of the group, and he was ill; terminally ill, I take it.

Mr. DANN. I remember Mr. Cooper because he was a squad leader, and I was also.

Mr. PREYER. And I take it that you have not been contacted by any official survey from the Government.

Mr. DANN. Negative, sir, I never have, no.

Mr. PREYER. Thank you very much.

Mr. ROGERS. Mr. Waxman?

Mr. WAXMAN. Thank you, Mr. Chairman. I want to thank you gentlemen for your testimony and your willingness to participate in this hearing; this has been very helpful for us.

Let me ask, Mr. Dann, maybe I will ask you this question, have you had problems with the Army in having them treat you for your health problems, or compensating you for the illness that has resulted?

Mr. DANN. I have applied for compensation through the DAV, and the VA has turned me down. I expect to appeal that.

Mr. WAXMAN. You expect to——

Mr. DANN. I expect to appeal.

Mr. WAXMAN. They turned you down?

Mr. DANN. Their decision, yes.

Mr. WAXMAN. And on what basis did they say they turned you down to compensate you for the injuries you have suffered?

Mr. DANN. There was no proof at all, it did not say overdosage, or whatever, that there was a relationship to my film badge, or anything. But that the symptoms that I had written down—much of what I report here—that they could not find it was service connected. That is all they said.

Mr. WAXMAN. Now, they are using the measurements on the badge as the sole criterion as to whether it was service related. They are not taking into consideration whether you inhaled radiation or had other exposure.

Mr. DANN. No, sir. How radiation affects you, I had no idea. What the diagnosis is—I just felt that it did, and I always said that it has been, but nobody would ever believe me. I even told the VA about 15 years ago that I thought I was—I would become lightheaded and I was treated for high blood pressure; I never had high blood pressure. They said I could possibly have a fluctuating blood pressure, and I was put on a salt-free diet.

Mr. **Waxman**. How soon after the atomic tests did you start noticing symptons that bothered you?

Mr. **Dann**. I started losing my hearing almost immediately in the left ear, and I cannot hear too well on the right one, either. But my teeth started falling out immediately, and my hair started falling out in blotches severely, all over my head.

Mr. **Waxman**. Now, does the Army have an explanation as to why you have suffered these things?

Mr. **Dann**. I went to the doctor, of course, but the doctor told me that he thought it was nerves because I am nervous, I guess.

Mr. **Waxman**. Were you advised before you involved yourself with these tests that there was a health danger from radiation?

Mr. **Dann**. I told the doctor that I was exposed to radiation, but they have no count of how high radiation we had. I had no access at all to any records of any radiation, or even who to contact. I thought they would contact me.

Mr. **Waxman**. How about you other gentlemen, have any of you had problems in getting the Army to treat you, or to compensate you for any injuries you have suffered?

Colonel **Keating**. I did not suffer any injuries. My treatment by the Army has been superior. I am retired, have been retired going on 19 years. I have had all of the medical treatment up until this time that could be expected—me and my family.

Mr. **Waxman**. Anyone else?

Colonel **Stedman**. That is my case also. I spent 13 more years in the Army after the test and was not aware of any medical problems, and this skin cancer thing just happened last year. I have not attempted to get any compensation from the Army.

Mr. **Waxman**. I see.

Mr. **Smith**. The only contact I made was with the VA because it happened to be nearby, when I thought I had to have an operation. They tried to help me but finally concluded there was nothing they could do to give me any assistance. So, I went to other sources.

Mr. **Waxman**. As I understand the test, Smoky is the one you were involved in, Mr. Dann, is that right?

Mr. **Dann**. Yes.

Mr. **Waxman**. That was supposed to be a scenario that was being played out where the United States was involved in a war with an aggressor involving nuclear weapons, and it was supposed to be a helicopter movement of troops into the area that had been detonated with atomic weapons. Is that correct?

Mr. **Dann**. Yes.

Colonel **Keating**. The scenario—which I helped write—was a worldwide situation derived down to our local area and down to the test site at Yucca Flats what we would do, is what it amounted to. They in theory came in and dropped that bomb, that was the concept of it.

Mr. **Waxman**. How much of a danger did the Army anticipate that the troops involved in this maneuver would be exposed to; did they warn you about possible radiation dangers?

Colonel **Keating**. Well, all my troops were always in trenches. To my knowledge there was nobody that was hurt from the blast. Now, whether there is anybody from the fallout, I do not know.

Mr. **Waxman**. Mr. Dann, were you warned that you were possibly taking a risk, that you might suffer from radiation?

Mr. **Dann**. Negative, not at all. We were just to be on open ground, and at that time, of course, we never questioned our superiors, we did follow orders. We stayed on our hill. We were knocked off our feet.

Mr. **Waxman**. You were knocked off your feet?

Mr. **Dann**. Certainly, I rolled 15, 20 feet. I lost my steel pot, but I held on to my rifle.

Colonel **Keating**. The impact from the blast—I do not know if you gentlemen have ever seen it—but from 5 miles away it will just about knock you off your feet on some of the ones before Smoky. One of the precautions they tell you to do is turn your back to it and do not rest your chin on your rifle because you can get your lips split; some who ignored this warning did receive split lips and had teeth knocked out. When the blast hits you it goes out in a tremendous force, it creates a complete void in the desert, and pretty soon it is all coming back in again. So, you have to wait until the blast is out and the blast returns, then you can move.

Mr. **Dann**. I might add something to that. In anticipation of an atomic shot anyone that is smart at all, of course would get behind a knoll, or a hill, to keep away from the direct rays and the thermo and the blast. And if anything is in between you and that shot, it is going to hit you. And if you are on open ground, such as a desert, you might just get peppered with sand and sagebrush; that is about what we were hit with. If there would have been buildings or machinery, concrete, things of that type, we would have been hit with that. But they were smart enough to know that.

Mr. **Waxman**. Mr. Chairman, I want to congratulate you and Congressman Carter for initiating these hearings. It seems the Army sent men out to be exposed to radiation dangers and did not advise them—if that was the case—that they were subjecting themselves to possible health hazards. Then afterward the Army denied any liability for it because it did not seem to fit into their plans. Then we read the news report in the Times, and the news report said:

> After the completion of the exercises they concluded that the GI's are physiologically and psychologically capable of using "A" bombs at close tactical range.

It just really strikes me as a horrible thought that through all these miscalculations someone can figure that a nuclear war is something that is acceptable, and reasonable, and possible as a way of handling the dilemmas in this world. I think this is a tremendously important hearing. I think you men have made an important contribution to our investigation, and I hope we will get the answers to some of these questions.

I think we ought not to delude ourselves into thinking that war, nuclear war particularly, is in any way a reasonable, acceptable way of carrying on in a civilized world. I do not think if the Army sent our men to be exposed to these kinds of dangers and then denied that there was any problem at all, that is a reasonable way for our Government to act. I just hope we will get to the bottom of these very important questions.

Mr. ROGERS. Thank you very much, Mr. Waxman.

Let me just ask this of anyone who might want to answer it, was there any discussion of why Smoky actually took place? Did they advise you that they were making film, public relations film? Were the troops told that? Were they told the would be engaging in a public relations exercise with other troops?

Colonel KEATING. I can answer that—I hope I can. The concept of Operation Smoky as a tactical operation was devised by the Army Ground Forces and Fort Benning, training personnel. They had representatives come to Fort Lewis, and my unit was selected as the unit that would participate. We were informed at that time that the scenario for the whole world situation would be developed, and at the time we got there, why, they would hand us a set of orders and that is when we started moving out.

When we got to Desert Rock the first problem, major problem, we had was to write the whole scenario ourselves. So, that delayed the training program so far as the senior officers because we had to go in and write the scenario and the program and had to get it down to the battle group.

But they did utilize it with the concept of trying to train personnel, in the event that there is a war, how are you going to handle it. Like Mr. Waxman said, maybe you never will have it, God willing. If he does not will, how do you handle it if you get it?

Mr. ROGERS. Well, they did not talk to you about it being a public relations operation.

Colonel KEATING. No, it was just a matter—the battle group concept was a new concept innovation of General Taylor's. I do not know if you gentlemen recall that. We did away with the old triangular division, three regiments, and all this sort of stuff, and we went into a 1,500-man battle group that was supposed to be a very fast-striking force, top mobility and top communications. This was supposed to be a test of the capability of this new type of unit.

Mr. ROGERS. I just wondered, did they tell you it was going to be such a terrific blast?

Colonel KEATING. Well, they told us it was going to be one of the biggest ones up to that time they had fired, yes. We were advised.

Mr. ROGERS. Forty-eight kt, where Hiroshima was 13.

Colonel KEATING. I do not know how big this was—twice as big.

Mr. ROGERS. Well, I notice the final report of operations "Exercise Desert Rock VII and VIII, the final report days, Infantry Troop Test, Shot Smoky, 30 August 1957. Purpose: To portray to the public the Army at its best——

Colonel KEATING. Well, it could have been.

Mr. ROGERS [continuing]. "Employing ROCID organization in operations under atomic warfare conditions in order to determine the limits of helicopter lift and troop participation."

Colonel Stedman, I think you started to say something.

Colonel STEDMAN. I have here a copy of a little brochure that was handed out to everybody when they arrived at Camp Desert Rock, that gave administrative hours of operations of clubs and buses, and so on. I thought this might pass some light on what the thought was. It says,

> In a world in which the free people have no nuclear monopoly the United States must keep its atomic strength at peak level. That is the reason tests are being held out here in Nevada.

That was the handout.

Mr. **Rogers**. It did not mention that it was to portray it to the public.

Colonel **Stedman**. No, sir, it does not.

[Testimony resumes on p. 178.]

[The brochure referred to follows:]

HEADQUARTERS
EXERCISE DESERT ROCK VII AND VIII
Camp Desert Rock
Las Vegas, Nevada

On behalf of the officers and men of Camp Desert Rock, I extend a warm welcome to you on your arrival. We believe you will find your participation in this atomic exercise most beneficial.

Our mission is to support the observers, participating troops and project personnel of the technical services who come here to take part in the tests, and to coordinate their participation with officials of the U.S. Atomic Energy Commission.

Over 7,000 Army personnel will observe this test series, either as individual observers, as members of troop units, or as representatives of the Army Engineers, Ordnance and Signal Corps, who will test material and equipment under atomic conditions. We will also support and coordinate the participation of 730 Air Force, 2300 Marine and 150 Navy personnel.

This means that at certain times the facilities of Camp Desert Rock will be taxed to full capacity. Some personal inconvenience is inevitable since we are operating under field conditions complicated by the exacting requirements imposed by the Atomic test program. However, everything possible within the limits of available financial and manpower resources has been done for your comfort and convenience.

This booklet will sketch for you what to expect while here. You may be assured that we will do everything possible to make your stay both pleasant and profitable.

WALTER A. JENSEN
Brigadier General USA
Deputy Exercise Director

NEVADA NUCLEAR TESTS

Prior to this present series the United States has explored a total of 45 nuclear devices at the Nevada Test Site since its openining in 1951. The Atomic Energy Commission has stated there are four areas of work involved in the laboratory and field test development of atomic weapons: primary experimental research, theoretical investigations and calculations, component development experimentation and full scale nuclear detonations. If any work area is neglected, the rate of weapons progress slows. The Nevada Test Site is where the AEC conducts its continental full scale nuclear detonations.

In a world in which the free people have no nuclear monopoly, the United States must keep its atomic strength at peak level. That is the reason tests are held periodically in Nevada.

Before the Nevada Test Site was chosen available locations were surveyed and checked against criteria such as density of population; weather, particularly for its effects on radiological safety locally and nationally; operational factors such as air lanes, labor pool and transportation; real estate available to the government; and security. The Nevada site most nearly satisfied all of the criteria for a continental site.

Each Nevada test has been successful in adding to scientific knowledge needed for development of atomic weapons and needed to strengthen our defense against enemy weapons. These tests have made it possible to design weapons suited to a wide variety of strategic and tactical situations and fitted to different military delivery vehicles. As a result the United States has developed a whole family of weapons with large yields and small. Because of the tests the Armed Forces are stronger andCivil Defense better prepared. So far as weapons development is concerned, continued continental, full scale testing is necessary to ensure an acceptable rate of advancement.

Certain military effects experiments can only be conducted in the Pacific, and certain experiments to be meaningful can only be conducted on land masses typical of continents. For those experiments which can be conducted in either the Pacific or in Nevada, they can be conducted in Nevada more quickly, more easily, more accurately, and with economy of men, material and dollars. Demonstration programs in Nevada stimulate public interest in national civil defense planning.

The most recent estimate of costs for Nevada test operations totaled $30,000,000 for a series of ten shots.

As weapons development work progress new ideas originate in the weapons laboratories, and new requirements for weapons are posed by the military, the Nevada Test Site Planning Board examines each proposed nuclear test to determine wheather it is technically necessary.

Before it is detonated each Nevada shot is justified as to its safety and a determination is made that its firing will be acceptable under established criteria for offsite radioactive fallout.

Technical requirements determine wheather a shot may be fired in daytime or darkness. Experiments involving photography usually require darkness. For this reason the immediate pre-dawn hours are used. A majority of shots in Nevada are fired before dawn.

OBSERVERS

About 5,000 observers and 6,000 participating troops will view the record number of detonations during Exercise Desert Rock VII and VIII. Fourteen projects involving 400 experiments are being conducted.

All observers who have not completed an orientation course will be given one the first day after arrival.

A day prior to the shot observers will tour the test site, receive a briefing in the trenches, and observe the equipment area.

One to three hours after detonation observers will return to the equipment area to inspect damage. Those so desiring may return to this area the next day if radiation safety monitoring is favorable.

Assistance in billeting, transportation, entertainment, reservations, special tours and information is provided by the Visitors Bureau.

HISTORY OF CAMP DESERT ROCK

Camp Desert Rock is located 65 miles northwest of Las Vegas. Established in September 1951, it has supported observers and troops participating in every military maneuver conducted in conjunction with atomic tests.

Originally a tent city, the camp is now a semi-permanent installation with 163 temporary buildings and a 4,200 foot airstrip. A large number of troops are quartered in squad tents during exercises.

Only a few men are stationed here in lulls between test series. When tests are scheduled, troops start to arrive months in advance to prepare the camp for use by the support and participating troops. The majority of the support troops for Exercise Desert Rock VII and VIII come from Fort Lewis, Washington, Fort Ord, California, Fort Riley, Kansas, Fort Huachuca, Arisona and Camp Irwin, California.

The sun, not the bomb is your worst enemy at Camp Desert Rock. To Quote Rudyard Kipling:

"The worst of your foes,

is the sun overhead;
If 'e finds you uncovered,
'E'll strike you down dead;
So keep on your 'elmet
for all that is said,
Or you'll die like the fool of a soldier."

Cold weather can invade the desert surprisingly - especially in the evening - so don't turn your blanket in. You may need it.

As a matter of record, the average maximum summer temperature is 102 degrees, but the mercury has hit 117 in the shade.

You may have the opportunity to do a bit of sun bathing while here, but watch it closely as it takes only a few minutes to broil a lobster red.

Summer rains are infrequent but sometimes are heavy and wash out roads and bridges without warning. It pays to keep a wary eye for flash floods in such potential trouble spots. Soon after the downpour the land is as dry as ever.

It's readily apparent we're hemmed in between mountain ranges. Just south of the Test Site are the Spring Mountains, which include Charleston Peak and Angel's Peak from which newsmen have observed many detonations. Our elevation is approximately 3,200 feet.

Death Valley is some fifty miles west of Camp along Highway 95. You may go by way of Lathrop Wells and Death Valley Junction or Beatty and Daylight Pass. If you're a ghost town enthusiast try a trip to Rhyolite, just seven miles from Beatty. The highest and lowest points in the United States, Mount Whitney and Badwater, can be seen from Dante's View.

Even desert aficionados may tire of looking at rocks and sand. A welcome change in scenery is found on the Colorado River and Lake Mead behind Hoover (Boulder) Dam, an easy drive, and swimming is available. The lake, located in Black Canyon, offers good fishing for all who brought along rods and reels. The Camp Special Services Office conducts a weekend excursion. Also when scheduled tests are delayed, special tours will be arranged. Tour information will be provided by the Visitors Bureau.

Points of interest include Zion and Bryce Canyon National Parks, the Grand Canyon and the High Sierras.

SECURITY

GENERAL

Measures employed to maintain the security of the Nevada Test Site and its operations are those required by the Atomic Energy Commission's security regulations.

The security program includes physical protection of the test site, its structures, equipment and materials and maintaining control over all persons entering to assure they have required clearance and that they enter only those areas where their presence is needed to advance test missions. Also included is the problem of contol of classified information, limiting access to properly cleared personnel. The general public is not permitted access to the Nevada Test Site.

BADGES

All permanent exercise personnel required to enter the test

ENLISTED RECREATION HALL

The Enlisted Recreation Hall is open weekdays from 1700 to 2200; Saturdays from 1200 to 2300 and Sundays from 1100 to 2200 hours. (Building 323).

ENTERTAINMENT

Theater showings are scheduled for 1815 and 2015 hours Monday through Saturday and at 1900 on Sunday. (Building 154).

Special Stage shows from Las Vegas have been arranged by the Special Service Office. These programs are presented Sunday at 1400 hours at the outdoor stage or in the Training Classroom if weather conditions make it necessary. (Building 155).

LIBRARY

A Special Services library offers more thatn 2,000 books for off-duty reading enjoyment. Hours are from 1300 to 2100 Monday through Friday and 1000 to 1600 Saturday and Sunday. (Building 627).

MEDICAL

Sick call is held Monday through Friday in the post dispensary at 0700 (Building 101). A two ward, 25 bed, station hospital is now operational for minor illness. Serious cases are cared for at the more extensive facilities at Nellis Air Force Base.

NCO CLUB

The NCO Club is open daily from 1130 to 1300 and from 1630 hours. During shot periods the club is open on a 24 hour basis. (Building 901).

OFFICERS CLUB

The Officers Club is open daily during the noon hour and from 1630 hours. On Saturday and Sunday the Club is open from 1100. (Building 99).

POST EXCHANGE

The Post Exchange is operated daily except Sunday from 1130 to 1900 for the convenience of all personnel at Camp Desert Rock. Saturday hours are from 1100 to 1400. (Building 327). Post Exchange facilities at Nellis Air Force Base are open to military personnel participating in Exercise Desert Rock VII and VIII.

POST OFFICE

The camp Post Office provides complete postal facilities. Mail distribution is made to individuals through their units and staff sections. Financial hours are from 0730 to 1100 and 1130 to 1600 hours Monday through Friday. (Building 156).

RELIGIOUS SERVICES

A chaplain is on duty at all times and services are conducted for all faiths. The schedule of religious services is as follows:
Catholic Mass; Daily at 1155 (Building 326)
Sunday at 1000 (Building 154)
Protestant Worship: Sunday at 0900 (Building 154)
Jewish Services: Friday at Jewish Community Center, Las Vegas. Transportation departs at 1815 hours from Camp Desert Rock. (Building 139)

SPORTS

A twilight softball league plays at the Camp Desert Rock diamond Monday, Tuesday and Wednesday at 1745 hours.

TRANSPORTATION

Commercial bus transportation is available to and from Camp Desert Rock. The schedule is as follows:

DAILY (7 DAYS)*

LEAVE	TIME	Arrive at DESERT ROCK	DESTINATION	TIME
Las Vegas	0930	1050	Reno	1900
Las Vegas	2030	2148	Reno	0700
Reno	0900	1720	Las Vegas	1850
Reno	0040	0912	Las Vegas	1040
Camp Desert Rock	1430	--	Las Vegas	1600
Las Vegas	0030	0200 ***		

SATURDAY AND SUNDAY ONLY **

LEAVE	TIME	DESTINATION	TIME
Camp Desert Rock	1400	Las Vegas	1520
Camp Desert Rock	1830	Las Vegas	1950
Las Vegas	2330	Camp Desert Rock	0050

FARES: Camp Desert Rock to Las Vegas (Round Trip) $2.05
Camp Desert Rock to Reno (Round Trip) $20.88

* Stops at Main Gate Only
** Stops at Officer's Club, NCO Club and EM Recreation Hall
*** Daily Except Saturday and Sunday

Mr. ROGERS. Were you aware that film was being taken, Colonel?

Colonel KEATING. They could have been.

Mr. ROGERS. But you are not aware of it.

Colonel KEATING. I do not recall it. I would be interested to know who has done the final action report on it. Who prepared that?

Mr. ROGERS. The Army, Headquarters 6th Army.

Colonel KEATING. I was not in on that.

Mr. ROGERS. Now, in planning, you planned the exercise. How close did you plan for the troops to come? I believe you said 3,000 yards?

Colonel KEATING. The objectives were within about 3,000 yards, or probably closer than that, I guess 150 yards, where they had placed tanks and other different pieces of equipment. In some instances they were just a hill, terrain that you took. These were the objectives that were designated for the different platoons to come up and neutralize.

Mr. ROGERS. Mr. Dann. I believe you said that you went up to within about 300 yards of ground zero?

Mr. DANN. Yes, sir, after we left the hill. We loaded into trucks and went down, observed the trenches that we were to be in, they were caved in. Then we walked down to ground zero within about 200 to 300 yards.

Mr. ROGERS. How long did that take, would you estimate? I know that is difficult.

Mr. DANN. From the top of the hill to ground zero?

Mr. ROGERS. Yes.

Mr. DANN. I imagine 15 to 20 minutes. The desert floor is pretty rough for a 5 ton.

Mr. ROGERS. Yes. And what about walking, how long did you walk?

Mr. DANN. From the trenches, where we left the trucks, we marched in platoon formations, went down there. I would say 10 minutes, possibly. There was so much dust, I did not keep track. Our dust from marching.

Mr. ROGERS. I understand that is difficult to recall.

Mr. DANN. I believe they just wanted us to see the devastation of the shot, and that the tower was completely gone. There was no crater.

Mr. ROGERS. Did any of you ever hear this operation called—among the troops—Guinea Pig?

Mr. DANN. Yes, sir.

Mr. ROGERS. Was that the general discussion about it?

Mr. DANN. Pardon me, sir?

Mr. ROGERS. What was the general talk among the troops?

Mr. DANN. The morale of the troops, I might add, was very low in our section. They had been there so long waiting for Shot Smoky that they did not care if they let it off in their back pocket. I think the higher echelon thought the same thing. It just seemed to me like it was a hasty shot, and even though the wind had shifted and would carry the radiation over our trenches, that they had overlooked that and had used observation, rather than safety.

Mr. ROGERS. Thank you.

Now, Colonel Keating, Mr. Dann was not in your troop. Were all of your troops in trenches?

Colonel KEATING. My troops that were observers were in trenches, the rest of them were behing the hills in the area, about 8,500 yards away, where the helicopters would——

Mr. ROGERS. Pick them up.

Colonel KEATING [continuing]. Come to pick them up and bring them to the assault area.

Mr. ROGERS. I see.

Colonel KEATING. And then there were intermediate objectives because also in this training program there was a resupply problem by helicopter where we would get to certain objectives and they would fly in and drop supplies to us, receiving ammunition and so forth, and then we would go to other objectives. It was pretty near a full day program.

Mr. ROGERS. I see. Did your officers have the responsibility of collecting the badges?

Colonel KEATING. I do not recall. I am sure each company had a roster for assignment, and we had to account for every badge.

Mr. ROGERS. And the AEC personnel, did you have much dealing with them?

Colonel KEATING. No, we just turned them in.

Mr. ROGERS. You just turned them over?

Colonel KEATING. At Desert Rock, there, they are the ones that conveyed them. We did not deal directly with the AEC.

Mr. ROGERS. Mr. Dann, what did the VA say about your situation in your hearing? You said your claim was denied. Could we have a copy of that denial?

Mr. DANN. I do not know if I have it with me or not, sir.

Mr. ROGERS. You may not have it here, but could you furnish it for the record?

Mr. DANN. Yes, sir, I could.

[The denial referred to follows:]

VETERANS ADMINISTRATION
CENTER
FEDERAL BUILDING, FORT SNELLING
ST. PAUL, MINNESOTA 55111

Date: December 23, 1977

In Reply Refer to: C 24 789 950
335/212B4

Mr. Russell J. Dann
1211 Spartan
Albert Lea, MN 56007

Your disability compensation claim has been carefully considered. To be entitled to compensation the evidence must show: (1) that you have a disability which was incurred in or aggravated by your service, in line of duty, and (2) it must be 10% or more disabling. The evidence, including your service records, does not meet these requirements. You are not, therefore, entitled to compensation.

Service connection has been denied because of the following:

Your fracture, cervical vertebrae with quadriplegia, chronic bronchitis, elevated SGOT, and penoscrotal fistule not incurred in or aggravated by your military service.

The radiation exposure, residuals which you claimed was not shown by the evidence of record.

You were represented by the Disabled American Veterans when your claim was considered.

J. R. Kelley

J. R. KELLEY
Adjudication Officer

Enclosure:
VA Form 1-4107

cc:
DAV

"To care for him who shall have borne the battle, and for his widow, and his orphan." – ABRAHAM LINCOLN

Mr. ROGERS. Do you recall any particular comments, other than just the denial?

Mr. DANN. None other than connections that I had, like a hearing, and this and that; that they see no reason why it was service connected. I had mentioned Shot Smoky, of course.

Mr. ROGERS. And I believe you wrote a letter to them about 15 years ago, did you say?

Mr. DANN. Yes, sir, I did.

Mr. ROGERS. What response did you get from them on that letter?

Mr. DANN. None other than what I have already mentioned.

Mr. ROGERS. In other words, you do not recall any specific reply from that.

Mr. DANN. No, sir, nothing in particular except that it had been denied.

Mr. ROGERS. And you were, as I recall, knocked about 15 feet by the blast.

Mr. DANN. Yes, sir. I was in the same group with Mr. Cooper.

Mr. ROGERS. I think Dr. Carter has a question.

Mr. CARTER. Thank you, Mr. Chairman. I know that the Army makes a statement concerning Smoky that where the troops were at the time of detonation the maximum wind velocity at their location was 7 miles per hour. Do you think that was the velocity when you were knocked over, Mr. Dann?

Mr. DANN. You said you want me to guesstimate what it would amount to?

Mr. CARTER. Yes, sir, about what was it? The Army said where troops were the wind caused by the blast would have been 7 miles per hour. What would you say it was?

Mr. DANN. I do not know what it takes to blow me off my feet.

Mr. CARTER. I believe it was estimated yesterday by one gentleman that it was more than 80 miles per hour. If I am not mistaken, Dr. Sperling testified he had calculated it to be that velocity where Mr. Cooper was at the blast.

Mr. DANN. Sir, I have no idea. I would say 100 miles per hour.

Mr. CARTER. Enough to blow you over at least, and a lot more than 7 miles per hour?

Mr. DANN. It was a heck of a tumble, sir.

Mr. CARTER. I am sure it was, and I regret it.

Colonel Keating, you helped write the scenario after you got to Desert Rock. Is that right?

Colonel KEATING. The one I read?

Mr. CARTER. Yes, sir. You were under the impression when you went there that it would already be written. Is that correct?

Colonel KEATING. We were advised the thing would be ready when we got there.

Mr. CARTER. But when you got there——

Colonel KEATING. It has nothing to do with this problem here. You were just asking who devised it. The Army ground forces and Fort Benning training personnel.

Mr. CARTER. I cannot hear you too well, sir.

Colonel KEATING. I said, the program was devised—the chairman was asking who devised it. It was devised by the Army ground forces and Fort Benning training personnel.

Mr. **Carter**. Yes, sir. But when you got there, you had to revise the scenario?

Colonel **Keating**. We wrote it.

Mr. **Carter**. You wrote it there.

Colonel **Keating**. I, myself, my S-3 section, the S-3 section from the 85th Aviation Company, and personnel from Desert Rock Headquarters.

Mr. **Carter**. Had you had a great deal of training in nuclear warfare at that time, sir?

Colonel **Keating**. That was a first.

Mr. **Carter**. That was a first, and you wrote the scenario for this without any training.

Colonel **Keating**. Well, you have books you read.

Mr. **Carter**. Yes, sir, I mean in this particular area.

Colonel **Keating**. I do not understand how you can have training in something we do not have, that would be difficult. We have to simulate.

Mr. **Carter**. Mr. Chairman, of course by 1957 we did know a great deal about the effects of nuclear explosions. Hiroshima and Nagasaki had occurred 12 years before, and I think anyone in charge of that scenario there and of the plans there should have had knowledge of what could happen to troops that were exposed to an atomic blast.

Colonel **Keating**. I was not the only one that was on the committee.

Mr. **Carter**. Yes, sir, I understand there were two others with you, and I suppose they lacked the training, as you did.

Colonel **Keating**. I do not know.

Mr. **Carter**. Thank you, sir.

Mr. **Rogers**. As I understood it, you said you really did not have much contact with the Atomic Energy Commission people.

Colonel **Keating**. All of our communication was through Desert Rock.

Mr. **Rogers**. Well, I just wondered if they had consulted in the planning of the exercise regarding the possible radiation.

Colonel **Keating**. I do not recall.

Mr. **Rogers**. You do not recall that. We thank each of you for being here.Your testimony is most helpful to the committee. It may be we will want to be in further touch with you, or if anything else comes to mind that you think will be helpful to the committee in its consideration, the committee would welcome receiving it from you.

Thank you for your effort, and thanks, too, to the DAV for its cooperation in helping this panel to be assembled.

Thank you for your presence and for your willingness to help the committee. Thank you. You are excused.

Mr. **Rogers**. Our next witness will be Dorothy B. Jones from Beverly Hills, Calif., representing, "Another Mother for Peace" organization.

We welcome you to the committee, Mrs. Jones. We appreciate your being here. Your statement will be made a part of the record in full at this point, and you may proceed.

STATEMENT OF DOROTHY B. JONES, MEMBER, STEERING COMMITTEE, "ANOTHER MOTHER FOR PEACE"

Mrs. JONES. All right. I appreciate the opportunity of being able to appear here today. My name is Dorothy B. Jones, and I am testifying as a member of the steering committee of Another Mother for Peace, which is a nonprofit, nonpartisan association of individuals with national headquarters in Beverly Hills, Calif., whose goal is to eliminate war as a means of settling international disputes.

I am a social scientist trained at the University of Chicago and have worked as a research director and consultant in industry and in government. Currently I am research director of the Another Mother Fund, a public foundation engaged in research on radiation monitoring and other nuclear-related matters.

Another Mother for Peace first became aware of the exposure of servicemen to radiation in nuclear tests after newspaper reports of Congressman Carter's efforts on behalf of these men. Last November 30 we held a press conference with Pat Broudy, widow of Maj. Charles Broudy, who died of lymphosarcoma, and we launched Project Searchlight, a nationwide effort to try to locate other men who were used as human guinea pigs by the Department of Defense and the Atomic Energy Commission in their testing of nuclear weapons in Nevada and in the Pacific. Since then we have been hearing from men in all parts of the country, and from widows and children of men who have died of leukemia, cancer, and other diseases which resulted from their exposure to radiation by their Government.

The tragic exposure of our servicemen, and also civilians, to nuclear blast and radiation during U.S. weapons testing goes far beyond the test named Smoky. We were informed by Major Skerker of the Department of Defense that there were 192 nuclear bomb tests prior to the Test Ban Treaty, 184 of which were in the atmosphere. Ninety-eight of these took place in the South Pacific, almost all of the others in Nevada. From Department of Defense documents and from the reports we have been receiving from many of those involved, it is clear that in most of these tests servicemen and others received multiple exposures to potentially dangerous levels of radiation.

The victims and their families express shock and outrage at the way they have been treated by their Government. Most testify that they were not informed of the risk involved. Most have spent long bitter years fighting to gain benefits they know are due them. Many are now suffering from leukemia, cancer, or other radiation-induced and radiation-related illnesses. All are demanding—and Another Mother for Peace is demanding—to know how it can be possible that the Congress has passed—and President Carter signed into law on October 5 of last year—legislation which will pay the people of the Marshall Islands up to $25,000 to any individual affected from fallout from our Pacific tests, and $100,000 in death benefits, while steadfastly refusing to recognize and pay service-connected claims submitted by our own men who participated in these same and other tests.

Although the full facts about the long-term effects of nuclear blast and radiation were not known at the time of the weapons testing, the dropping of the atom bombs on Hiroshima and Nagasaki in 1945 have been and are still referred to by the Department of Defense as "Tests." And the following year, in 1946, the Department of Defense and the AEC began Project Crossroads in the Pacific to continue testing the atom bomb—this time with our own men as guinea pigs.

Surely the human suffering and devastation which resulted from the Nagasaki and Hiroshima so-called tests, where over 200,000 people died instantly, should have convinced the Department of Defense and the AEC to hesitate to expose our own men, or anyone, to the radiation and blast effects of tests. Instead, they doubled and tripled the force and yield of the blasts—and played Army games—jeopardizing the lives of hundreds of thousands of Americans who were uninformed of the possible consequences and trustful of those in authority.

We charge the Department of Defense and the AEC with criminal disregard for the life and health of the men for whom they were responsible. There was casualness—and extreme carelessness—in the exposure of our men.

I present only a few examples, for which full documentation is submitted for the record.

During "Operations Crossroads", George Tjeerdema and other Navy men were ordered to board the U.S.S. *Bladen* while radiation levels were still high after a nuclear blast. The men were told to decontaminate the vessel without previous instructions, so they had to do the best they could without specific orders. This was reported by George Tjeerdema who served on the U.S.S. *Bladen*. He filed for service-connected disability and was refused. He died in 1966 from lymphoma.

I want to say here, I have complete documentation for every case that I am presenting.

There was often negligence in keeping records of the extent of exposure of the men. Morton Kenneth Kaplan served in the U.S. Navy during Operation Redwing in Eniwetok. His unit operated ICM's and the men were exposed to radiation from many H bomb tests. But they were told they were being monitored to make certain that each man's cumulative dose was safe, since their film badges were being regularly sent to Cleveland. After months of exposure, an officer attached to his unit discovered a huge supply of used film badges that obviously had never been sent to Cleveland. When he left the service Morton Kaplan married. He and his wife tried unsuccessfully to have children, and he learned from Dr. Cohler of Chicago, a specialist in sterility, that he had a absolute lack of any sperm count due, the doctor said, to his radiation exposure.

We have records of men in varous services who were not properly protected against radiation during these bomb experiments while officers and scientists wore protective clothing. For example, Artie Duval, who served in the Navy and whose case I will refer to later, was one of a crew of four men who transported scientists to an atoll on which a blast had taken place the previous day. The scientists wore heavy protective garments. The crew wore shorts and had no protection of any kind against exposure to the high levels of radiation on the atoll.

Another Mother for Peace also charges the medical doctors of the Department of Defense and the Veterans' Administration with deceit and medical malpractice. By 1964 it was well known to scientists and to medical men in the military that American servicemen and others who had been exposed to radiation in the Marshall Islands and in Nevada faced increased risks of leukemia, cancer, and other illnesses. But despite our government's medical findings and knowledge, no serviceman whom we have heard from or about, was ever notified of the fact that he should check with his doctor for symptoms of the many possible radiation-induced and radiation-connected illnesses which might beset him.

Every citizen has been warned again and again by the American Cancer Institute that the secret of effective treatment lies in early detection. Yet, our own government failed to notify those who were at risk as a result of following military orders during their years of service to their country.

Furthermore, in case after case men were told when they were ordered into situations where they were to be subjected to intermittent radiation exposure, often at high levels, that they had nothing to worry about because their cases would be carefully followed up—that they would be checked regularly at weekly or monthly intervals for 7 years or more. The men we have heard from report that no followup of any kind was made to see whether they showed or developed any symptoms as a result of their exposure.

There are many examples of this type of medical malfeasance. I cite one: Orville Eugene Kelly was a sergeant first class in the U.S. Army who spent 13 months in 1957 and 1958 at Enewitok atoll in the Marshall Islands in charge of Site David—Japtan Island—one of the three occupied islands in the atoll during the testing, with a varying population of 12 to 40 servicemen under his command. In the affidavit he prepared for Another Mother for Peace, for this hearing Kelly states:

> We were closer to ground zero during blasts than anyone else in the atoll, as nearly as I could determine. My recollection is that we were exposed to between 20 and 40 detonations. Prior to each blast, just before dawn, I, as commander of the island, was required to awaken all men, including those who had been working the night shift, and have them line up on the beach, facing the forthcoming blast. We were given protective clothing and eye goggles for protection. With the aid of an extension cord, I had to bring the countdown receiver to the beach and all men were required to observe the blasts—I never did find out why this was necessary. I recall that there was at least one fallout, due to an unanticipated rainfall following a blast.

Kelly complained many times to the medical officer on behalf of himself and his men but received no help other than sedatives for sleep. The men were never given a medical examination. When he and the others eventually left the atoll, there was no followup made by either the Surgeon General's office or the Veterans' Administration. Orville Kelly's affidavit concludes with these words:

> As I recall, all the equipment used in the testing area was destroyed instead of being brought back to the United States—all but the U.S. serviceman. He was sent home and forgotten—not even warned about the potential hazards of cancer.

Orville Kelly is living with terminal cancer—lymphocytic lymphoma. He has been refused service-connected benefits. In his words:

I served my country in what was then considered an important assignment. Now I am living with terminal cancer and facing the inevitability of leaving behind me, upon my death, a wife and four children to survive through whatever social security benefits are available and possibly through welfare payments.

Regardless of where the fault lies—with the top administration decisionmakers—with military officials—with the AEC—or with the medical doctors themselves, the fact remains that what was done and what was not done was inexcusable.

This last charge we make is perhaps the most serious of all, and I would like to give the evidence first. There are many examples—I report a few.

Artie E. Duvall, Jr. was involved in a top secret project called Operation Greenhouse while serving in the U.S. Navy from 1950 to 1952. He served aboard the U.S.S. *Cabildo* (LSD–16), which carried personnel and equipment to the site of a nuclear blast on Eniwetok Atoll in the Pacific in 1951. During the months of April and May 1951, he was involved in four events in which he and three other members of his boat crew were ordered to go to the atoll when a bomb had been detonated—and each time were exposed to high levels of radiation. The third time—May 8, 1951—when they conducted well protected scientists to the testsite, he was on the island for an entire day.

Mr. ROGERS. May I interrupt you? I will have the staff check that and maybe we will have it included as part of our hearings.

[See p. 191.]

Mrs. JONES. Thank you, Mr. Chairman.

A Board of Inquiry was held in connection with this third event. He was told that he had been exposed to lethal radiation and that he could not reveal any of the facts regarding this event for 10 years on penalty of 10 years in prison and $10,000 fine. The doctor at the inquiry told him that he must never have more radiation, not even X-ray. Regardless of this, he was sent on a fourth, "a personnel mission," the purpose of which was to test the capacity of the men to withstand very high doses of radiation.

Mr. Duvall was hospitalized. His white blood count became so low that the doctors could not believe he could still be alive. His radiation exposure record shows that he received a whole body gamma dose of 15,720 mrem, but he believes from the statements made to him at the time that it was much higher.

Artie Duvall kept his oath of secrecy for 10 years. When he applied for service-connected benefits he was told that one of the reasons his claim could not be approved was because he had waited so long to apply. And when he asked for his hospital records for the period immediately following his exposure to prove his disability, he was told that they were not available because they were classified top secret.

Most of the servicemen we are hearing from tell of being told that their records were burned in the St. Louis fire. Neither Another Mother for Peace nor the veterans themselves believe that there is only one copy of service and medical records.

In general, records relating to the time period of the Nevada weapons tests and those in the Pacific are frequently missing; medical records covering illnesses suffered by servicemen immediately after participation in nuclear tests are consistently unavailable. In addition, the level of radiation recorded on the serviceman's medical record is sometimes removed. Robert L. Kingsbury, a retired major in the U.S. Army, who is the Director of the Department of Military and Veterans' Affairs of the County of Los Angeles, was present at Shot Keppler in 1957. In his letter to Another Mother for Peace dated December 1, 1977, he states:

> I spent a total of 23 years in the Army, and I personally saw a statement of my medical records on numerous occasions that reported the dosage received at the test site. I made repeated attempts to secure my records and was advised that they were lost. Then, in July of this year, I made another attempt and received a copy, but with the dosage report missing. Like you, I feel something very strange is occurring.

Robert Kingsbury also stated in this same letter that a doctor at the Center for Disease Control stated on the phone that he, Kingsbury, was not the first military man to report that dosage figures had disappeared from medical records after such figures had been seen at an earlier date.

Another Mother for Peace charges that there is and has been for years a coverup by the Department of Defense, the AEC and the Veterans Administration—a consistent attempt at many levels to hide from the public the facts about experimentation with servicemen in nuclear testing, as well as a consistent attempt to deny to the victims medical records, verification of their presence at certain tests, and other information essential to their receiving rightful service-connected benefits.

The hopeless situation of the veteran is well summarized by Lyda Ragusa whose husband, after 21 years of military service, died of lymphosarcoma leukemia as a result of his exposure on the Nevada Flats to an atom test that misfired.

> I've been through the Board of Veterans Appeals years ago—a personal interview with five so-called authorities at one end of the room with a tape recorder and you at the other end of a long table alone. They ask, "What proof do you have your husband died of radiation exposure?" You have only the word of your specialist, as the Army will give you none. You have knowledge of his time and place—but you can't verify it because the Army won't. You really have nothing except the fact that your husband is dead.

Mrs. Ragusa and thousands like her are denied the right to have an attorney. The law provides—38 U.S.C. Sec. 3404C(a)—that no attorney can receive more than a total of $10 for representing a veteran who is seeking a claim. If an attorney is paid more than this amount, he can be fined $500 or imprisoned at hard labor for up to 2 years, or both—Sec. 3405.

We ask this subcommittee to consider or refer to the appropriate committee of Congress for study the basis on which Veterans Administration Appeal Board decisions are being made. There appear to be many inconsistencies and inequities which have come to our attention. For example, on June 19, 1967, Mrs. Jean M. Wahler, widow of an Air Force officer, after a 2-year fight won her decision from the Veterans Appeals Board in Washington that her husband's death from leukemia resulted from radiation exposure of 890 mrem. Her documents are here for the record. Why, then, does Artie Duvall, whose records clearly prove his presence and exposure at nuclear tests to radiation totaling 15,720 mrem have such difficulty in obtaining service-connected benefits?

Finally, Another Mother for Peace would like to emphasize that any and all studies which are being carried on of servicemen exposed to radiation in weapons tests are being misused by the Department of Energy, the Department of Defense, and the Veterans Administration to postpone the proper payments for service-connected disability benefits to these men, and this misuse appears to be part of a plan to promote endless delays of such benefits for the leukemias, cancers, and other diseases servicemen and civilians are suffering from because of their exposure at weapons tests.

Comprehensive followup studies were made of the Nagasaki and Hiroshima survivors over many years by our Government. And on the basis of the U.S. Navy's 20-year study of the Marshall Islanders. Congress has already voted to pay indemnity to the island people of Bikini, Rondalap and Utirik. Many thousands of our own men or their surviving families are suffering now and are in need of the benefits to which they are entitled.

Another Mother for Peace should not have to be making the search for the victims of U.S. experiments with nuclear weapons tests. The Government should make public the names on the ERDA—now Department of Energy—computer list of the 200,000 who were involved and should be on radio and television day after day until all those surviving men and their families have been found and paid the service-connected benefits they are entitled to. We are not going to rest until we see this done.

Mr. ROGERS. Thank you very much, Mrs. Jones, for a very revealing statement. I might say, the committee will furnish copies of your statement to the Department of Energy, the Department of Defense, and the VA and ask them to comment specifically back to the committee on your statements made.

Mrs. JONES. Thank you.

Mr. ROGERS. Also, I must say, we had asked a high official in the Department of Energy to be here today to testify. He could not, he told us because he had to go to Japan so he could check on the study of the Japanese people who might have been affected by radiation from the bomb there. So, I must say, there must be some validity to the charges you make.

We will have that official here on the 8th of February, however. But I thought there was a bit of irony there, I presume, that he could not be here to begin these hearings, but had to be in Japan. Dr. Carter?

Mr. CARTER. I submit that we should subpena him if he does not appear, if he refuses to appear again.

Mr. ROGERS. I think there is no question of his appearing. He will. He just had this important meeting, he said, to be in Japan to check on the people who might have been affected by an atomic blast in Japan. I am not sure where we place our priorities.

Mr. Florio?

Mr. FLORIO. Thank you, Mr. Chairman.

Ma'am, we appreciate your testimony which contains a great number of rather bitter and tragic ironies. Obviously we are going to spend an awful lot of time trying to get to the bottom of some of the cases you are talking about; and perhaps even more importantly, to evaluate the procedures, get the epidemiological studies under way so as to be able to gain from these unfortunate events in terms of prospective procedures that must be followed.

I am interested in the CDC study, which has not had turned over to it the entire list DOE has of the 200,000 people that have been exposed, in part because the Privacy Act precludes the revealing of records without the permission of the individuals.

I am interested if you have any information as to whether DOE has attempted to reach out to these individuals, notifying them about any of this, so as to be able to obtain permission to turn the records over to CDC for followup studies. Do you have any information on that?

Mrs. JONES. No individuals who have contacted us, and we have cases that are coming to us, one to three or four a day. None of the people who have been in touch with us have been contacted.

Mr. FLORIO. In other words, this is a hit and miss thing, if someone reads about it or has it brought to their attention they become informed, but as far as you know there is no systematic effort to reach out to all the people who have been exposed. To inform them, at a minimum, to go see a doctor; or to attempt to obtain permission to make their records available to the medical entity that is now looking into the problem.

Mrs. JONES. That is correct. We also are hearing from many civilians, and some of them received tragic exposure, also. One of them, for instance, Francis Hassler, a civilian employee of the Air force, was sent from McCullen Air Force base to the Pacific and had to work on aircraft which were being used in nuclear weapons tests. He requested a dosimeter to be able to protect himself against working on planes which were highly radioactive from fallout—but his request was refused. This man suffered radiation sickness directly afterwards for a month and-a-half; and he had absolutely no satisfaction in all of his efforts to get the Air Force to accept any responsibility for his continuing illnesses. They paid no attention. He gets no response. Yet he was a civilian employee of the Air force when he was exposed and suffered severe radiation sickness.

We are also hearing from individuals who worked for some of the construction companies who were under contract to the AEC in the testing in Nevada, people who were allowed to be exposed in a most shocking manner. For instance, John Carroll for a period of 8 years worked on the underground nuclear blasts, going in and taking the material out immediately after the tests. He too, has suffered from cancer, and was never told of the dangers he faced from radiation exposure during those years.

Mr. FLORIO. Just one final question. Has there been any evidence, or any expression of concern by any of the individuals who have been exposed with regard to genetic damage to the children of these individuals?

Mrs. JONES. Yes, there has been a great deal of concern expressed, particularly on the part of the wives of men who have children. Some report that their children have certain defects that they are not certain are attributable to the exposure of their husbands. Some do not have any problems but are just tremendously worried and concerned that something will turn up. So, there is great anxiety on the part of these people, even those who have not yet become ill and may never become ill.

Mr. FLORIO. Thank you very much.

Mr. ROGERS. Thank you so much, your testimony has been most helpful. Dr. Carter has some questions.

Mr. CARTER. Mrs. Jones, I want to thank you for your appearance. I want to thank you for the wonderful paper which you presented here today. I think it was tremendous. You have brought out the names of men who have lymphosarcoma, leukemia and other cancers, and other diseases which were the result of the radiation exposure which they received.

One of the most deplorable things I noted in your testimony was the fact that some of the scientists went on an atoll completely equipped, completely dressed in protective clothing, and at the same time they took our servicemen in without any protection. I think that constituted a heinous crime. Certainly, I feel that the families of our men who have died as a result of these atomic explosions should be fully compensated, and steps should be taken in that direction. To compensate the Marshall Islanders and then to deny our own soldiers is a travesty.

I want to thank you again.

Mrs. JONES. I would like, in addition to the records of those people mentioned in my testimony, also to place in the record—(in case the mails have not brought it to you, they being rather uncertain)—the testimony of Ronald Bakal.

Mr. ROGERS. Without objection it will be made a part of the record.

Mrs. JONES. Thank you very much.

Mr. ROGERS. If you would hand that statement to the reporter we will be sure that statement gets in. Thank you.

[The records—affidavits, medical histories, and other relevant documents—referred to by Mrs. Jones may be found in the subcommittee files.]

[Attached letters to Mrs. Jones prepared statement follow:]

804 Redwood Drive
Garberville, CA 95440
October 6, 1977

Max Cleland, Director
Veterans Administration
810 Vermont Avenue N.W.
Washington, D.C. 20420

C# 13 889 928
SN: 565 7781
SS: 569-26-0342

Dear Mr. Cleland,

I am writing to you in desperation after having exhausted all possible hope for justice through the San Francisco Veterans Administration Regional Office.

Although there are reams of correspondence, records and data concerning my case, they are available to you as a matter of record, so I have not included them here. What I have included are copies of a few documents indicating, in a small way, the causes of my frustration.

I was involved in a Top Secret project called Operation Greenhouse while serving in the U.S. Navy from 1950 to 1952. I served aboard the USS CABILDO (LSD-16) which carried personnel and equipment to the site of a nuclear blast on Eniwetok Atoll in the Pacific in 1951. I was exposed to intense radiation along with other members of the crew. Three other crew members and myself became nauseous as a direct result of radiation exposure. Since that exposure, my visual acuity went from 20/20 to 20/50 (an almost immediate result). My white-blood-cell count rose dramatically and I underwent a tonsillectomy. I have had a bad heart attack, open-heart surgery, and recurring symptoms of cardio-vascular disease.

My efforts to service-connect radiation poisoning have received run-arounds, stalls, double-talk and misinformation from the Surgeon General's Office which I consider nothing but lies. I am considering going to the press for public exposure and in the hope that others in a similar predicament will come forward.

Thank you for your time and consideration.

Sincerely,

Artie E. Duvall, Jr.

Enclosures

cc: Honorable Don H. Clausen

DISABLED AMERICAN VETERANS

V. A. REGIONAL OFFICE
211 MAIN STREET · ROOM 1210
SAN FRANCISCO, CALIFORNIA 94105

August 8, 1977

C: 13 889 928

Mr. Artie E. Duvall, Jr.
804 Redwood Drive
Garberville, CA 95440

Dear Mr. Duvall,

This is in reference to your pending claim with the Veterans Administration for establishment of service connection for residuals of radiation exposure and secondary heart condition with myocardial infarction, eye condition, hearing loss, memory loss, and circulatory disturbances.

I have been informed by the Adjudication Division that a personal hearing conducted, November 11, 1976, has not been incorporated in your Veterans Administration claims folder. The Chairman of the Board has informed me that the transcript of this hearing apparently is lost. Attempts to locate it through special search have been to no avail.

The members of the Rating Board, at this time, request you to state your contentions on the enclosed VA Form 21-4138, Statement in Support of Claim. Should you desire another hearing to be rescheduled, please let me know and I will initiate the necessary action.

Should there be further questions, please feel free to contact me.

Sincerely,

John M Parker
JOHN M. PARKER
National Service Officer

JMP:jhm

Enclosure

[A letter from Mr. Bakal follows:]

Ronald G. Bakal
Attorney at Law
8447 Wilshire Boulevard Suite 409
Beverly Hills, California 90211

(213) 655-0242 · 655-0243

January 20, 1978

Congressman Paul Rogers
Chairman, Subcommittee on Health & Enviornment
R/R Committee on Interstate & Foreign Commerce
House Office Building
Washington, D. C. 20515

Dear Congressman Rogers:

I am writing to you to express my views regarding the hearings you are holding on January 25, 1978, in respect to the long-term effects on our nuclear testing practices in Nevada and the Pacific.

For the last three years I have represented the inhabitants of Utirik Atol in the Marshall Islands in their attempts to secure adequate medical care and just compensation for the damages they suffered as a result of their exposure to low levels of radiation from the Bravo test of March 1954.

The lessons that have been learned from the experience in the Marshalls have been helpful in my understanding of the absolute necessity for immediate help for all of the potential victims of all of our atmospheric tests. The significance of the Utirik and Rongelap results was that the physcians and scientists who insisted that there was some magical threshold figure of rads, which would result in the long term development of malignancies, were incorrect. These same physcians and scientists have now insisted that there is still a threshold figure, but just a lower one.
QUESTION 1. On what evidence do they support this theory?
It is my position that the present National Center for Disease Control study that your Committee is analyzing is unnecessary. It creates a impression that the data needed to support a conclusion that those military and non-military personnel physically present at the 1957 Smokey test were subjected to a disease-causing level of radiation is yet to be discovered.

Dr. Glynn Caldwell has indicated among his assumptions that those individuals who were within the eight (8) mile radius of ground zero are the ones who he feels were within a possible zone of danger. QUESTION 2. How far were the people of Utirik Atol from ground zero at the Bravo test? There is significant comparable evidence available from both the Japanese and Marshall Island experiences to create a presumption that all of our military and non-military personnel at all of the testing, who were irradiated regardless of the amounts, (such amount cannot be adequately calculated due to undocumented inhalation of radioactive particles and the haphazard use of radioactive sensor badges) are in immediate danger of contracting radiation related disease.

The study, even if needed, is seeking ridiculously narrow results, which if positive, would create the need for more studies. QUESTION 3. Will the present study inform us about the causal relations between diseases other than Leukemia? QUESTION 4. Will it be necessary to do a study of every one of the hundreds of tests if the scientists are relying upon the threshold concept of irradiation? QUESTION 5. Will the study reveal any information about the potential genetic effects to the children of the exposed group? (There have been reported cases of second generation diseases in the Marshallese.) QUESTION 6. If more studies are needed, how long will it take? QUESTION 7. Will the results come too late for the thousands who may now be suffering from such diseases?

This last question leads me to a subject of more recent concern. In my representation of one G. I. irradiated on three separate occasions during the testing program, I have discovered that presently such an afflicted individual has little, if any, administrative or judicial remedy to establish our Government's responsibility. Case law, through the Ferris Doctrine, creates a complete bar for military personnel from suing the United States Government for negligence. The Courts have rationalized that there are sufficient administrative remedies within the Veteran's Administration to protect these individuals, including compensation. However, as of this date, hundreds of Veterans have been turned down for in-service-disability-benefits on the basis that they cannot supply the necessary medical proof. QUESTION 8. Is the V.A. waiting for the results of the present and future C.D.C. studies?

In conclusion, I recommend the following:

1. Your committee call for more in-depth hearings on the whole issue of low level radiation.
2. The C.D.C. study be terminated, or if not, broadened so that there will be some meaningful results to all of those present during the 15 years of nuclear testing.
3. That the Veteran's Administration policy of denying in-service-disability pensions be investigated.

I sincerely hope that my views and questions will stimulate action toward correcting deficiencies in our Government's present attitude toward this problem.

Respectfully Submitted,

Ronald G. Bakal

RONALD G. BAKAL

Mr. ROGERS. Our next witnesses will be Dr. William Foege, who is the Director of the Center for Disease Control, the U.S. Public Health Service, along with Dr. Glyn Caldwell, an epidemiologist from the Center for Disease Control, U.S. Public Health Service.

We welcome you gentlemen to the committee. We will be pleased to receive your testimony, it will be made a part of the record at this point without objection.

You may proceed, Dr. Foege.

STATEMENT OF WILLIAM H. FOEGE, M.D., DIRECTOR, CENTER FOR DISEASE CONTROL, PUBLIC HEALTH SERVICE, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, ACCOMPANIED BY GLYN CALDWELL, M.D., LEAD EPIDEMIOLOGIST

Dr. FOEGE. Thank you, Mr. Chairman and members of the subcommittee. We welcome this chance to appear and discuss the study that we have been doing on persons exposed to Smoky, the study of disease incidence, especially leukemia and cancer and its possible association with atomic nuclear radiation, which is of prime importance to the American public.

I am accompanied by Dr. Caldwell, the CDC's lead epidemiologist in investigating the incidence of leukemia and cancer among persons exposed to Smoky. As part of our testimony, with your permission, Mr. Chairman, I would like to read a letter from Secretary Califano to you.

Mr. ROGERS. May I say that this is, I understand, in response to the letter that Dr. Carter and I wrote on December 22, 1977, to the Secretary, concerning the rumor we heard that there were efforts underway to take away from CDC the control direction and the study, and have it transferred to another agency or group, and turn the funding over to the Department of Defense, or the Department of Energy. We were concerned about that because of the possible conflict of interest there, and we felt that it should be controlled and carried out by CDC, which does not have a direct interest in the outcome of this study; and also, the knowledge of health, expertise that exists in the CDC should be used. So, this is the Secretary's reply to our letter?

Dr. FOEGE. That is right.

Mr. ROGERS. You may proceed.

Dr. FOEGE. The letter says, "Dear Mr. Chairman. This is in response to your letter of the 22d urging me to expedite the Center for Disease Control (CDC) study of men exposed to radiation during atmospheric nuclear tests, and the questions you have raised in subsequent conversations with me.

"Let me begin by assuring you that no agreement or plan exists to relieve CDC of responsibility for conducting an epidemiologic survey of soldiers present at the so-called Smoky nuclear test of August 31, 1957. The Center for Disease Control will continue to study the incidence of leukemia and cancer in men present at the Smoky test as rapidly as the data can be collected and analyzed. We consider this survey our responsibility, and we shall carry it out. As you urged, I have directed that the study be expedited to the maximum extent possible.

"The CDC study of the Smoky nuclear test has been making progress. To date CDC has obtained information on nearly 500 of the 3,153 men known to be present at the test. Of those 500, CDC believes that it has identified eight individuals with leukemia.

"These findings are unquestionably cause for concern. Based on data developed by the National Cancer Institute, if all the men wearing film badges at the 1957 Smoky test were approximately 22 years of age at the time of the test, CDC would expect to find about two cases of leukemia in that group of 3,153. CDC believes, however, that there might have been a significant number of older men, that is, commissioned and noncommissioned officers, which would increase the number of expected cases of leukemia. The eight cases of leukemia discovered so far might also be the result of other variables, such as presence at repeated tests or additional occupational exposures.

"It is still possible, therefore, that the eight leukemia cases may be the result of other factors and not just presence at Smoky. If several more cases of leukemia are found in the more than 2,600 individuals that CDC has not yet located, however, the study's results would then strongly suggest that presence at the Smoky test had put these men at increased risk.

"Further and more intense epidemiological investigations of this group are necessary to determine the actual age distribution of the men present, the actual extent of exposure to radiation, and the existence of any other variables that might account for an increased incidence of leukemia. These investigations have been stepped up in response to your request, and as a result of the incidence of leukemia already discovered.

"While there has never been any doubt about the CDC's responsibility to carry out the study of the Smoky test, there have been discussions with other departments and agencies about a broader survey of other nuclear tests conducted during the 1950's—possibly involving up to 70,000-to 80,000 individuals or more.

"Based on the results to date of personnel present at the Smoky test, CDC believes that planning of this broader survey should be undertaken promptly.

"A meeting was held by the Department of Defense on December 1, 1977, to discuss the planning of a broader study. But many questions still remain open about how that study should be conducted, including how it should be funded, as well as the precise institutional arrangements for overseeing and supervising it. CDC officials have assured me that only the larger survey was discussed at the December 1 meeting. CDC's responsibility and commitment to carry out the study of Smoky has remained clear throughout these discussions.

"I agree with you that any study in this area should be conducted with complete independence to assure public confidence in its findings and conclusions. The Department stands ready to work with you, Congressman Carter, and your committee, as well as other agencies in the Government, to develop a completely independent and thoroughly sound study of other nuclear tests conducted in the 1950's."

The Secretary then closes by stating that, "In view of your interest and the important implications of this research for the public health * * *," he has asked me to testify this morning at your hearings.

Mr. ROGERS. Thank you. I hope you will relate to the Secretary the commendations of the committee for his attitude for seeing that CDC will continue. We are also concerned that CDC be heavily involved in broader tests, and it not be turned over to the Department of Defense or Department of Energy.

Dr. FOEGE. Thank you, I will.

Mr. ROGERS. Thank you, you may proceed.

Dr. FOEGE. In late November 1975, a former CDC physician epidemiologist working at the Veterans Administration Hospital in Salt Lake City, Utah, learned of a patient with acute myelocytic leukemia who reported having been present at an atmospheric nuclear test in Nevada. The nuclear test, nicknamed Smoky, took place on August 31, 1957. The physician contacted CDC because of our interest in cancer cases or case clusters occurring in unusual circumstances. When cancer or leukemia is diagnosed in association with apparently unusual animal, chemical, viral, or radiation exposures, such cases deserve epidemiologic investigation, both as a service to State and local health departments and as a mechanism for developing hypotheses concerning disease causation.

Since ionizing radiation is a well-known cause of cancer and particularly of leukemia, the case reported to CDC raised two possibilities, if in fact it was at all related to nuclear radiation exposure: The first possibility, that radiation levels previously thought safe might actually be carcinogenic; or two, that radiation exposure during nuclear tests might have been greater than originally supposed. To test these possibilities, CDC proposed to identify all persons present at Smoky and then to determine their subsequent incidence of cancer and leukemia.

Initial inquiries made to the Energy Research and Development Agency, now the Department of Energy, confirmed that nuclear tests had occurred involving troop exposure, but that radiation had apparently been within accepted safe limits. Numerous telephone inquiries were then made, attempting to identify particular persons present at Smoky. We werc seeking identification of military and civilian groups present, names or persons, their ages or dates of birth, specific dates of exposure, sources of current addresses, and, finally, whatever information might be recorded concerning cases of cancer or leukemia.

One of our early contacts was with the Armed Forces Radiobiology Research Institute in the Department of Defense, where we learned that no systematic records concerning persons exposed during testing had been kept during the 1940's and 1950's, but that beginning in 1964 some data had been assembled retrospectively. These records were said to contain name, year of exposure, amount of radiation received, and, in some instances, serial number, permanent duty station, test exercise unit, service number, social security number, and rank. If we could provide names, service numbers, and social security numbers—data which we did not have at that time—the Armed Forces Radiobiology Institute might be able to provide radiation exposure data. To explore this possibility further, we contacted the Surgeon General of the Army on April 25, 1977.

In early 1977 the Salt Lake City VA patient's story appeared in the news media. Subsequently CDC received numerous telephone calls and letters concerning persons thought to have been present at nuclear tests. Among these was a letter from a second leukemia patient who had also been present at Smoky.

On June 19, 1977, a story in Parade magazine resulted in over 2,000 letters and nearly as many phone calls from individuals reportedly present at various nuclear tests starting in 1945 W also received letters from a number of leukemia and cancer patients or their families, claiming to have been present at Smoky or at other tests in other years. From these contacts and from similar letters and calls subsequently, we have to date identified 447 persons present at Smoky, and 3 additional cases of leukemia, bringing the total cases to 5.

In the meantime, however, through a variety of sources, we were able to identify a list of military units present at Smoky. This list was sent to the Surgeon General of the Army to be collated by Radio Biology Research Institute personnel with radiation film badge records.The compilation of these data was completed and forwarded to CDC by the Army Surgeon General on August 19, 1977. The list provided name, serial number, rank, and film badge radiation dose for 3,153 Army personnel present at Smoky.

As soon as this list became available, two systematic efforts were begun to identify cases of cancer or leukemia among this group of men. The first effort was to match these names against the diagnostic files of the Armed Forces Institute of Pathology. From this matching two additional leukemia cases were identified, bringing the total at that point to seven.

The second effort was to match the list of names against VA death benefit files. This task was partly completed on January 5, 1978, when the VA provided CDC with a matched listing indicating that 164 men in the group had died. Death certificates for these 164 deaths are presently being obtaind by the VA through their regional record centers; 80 have already been received, and from this source an eighth case has recently been identified. From the VA listing it also appears that additional medical and identifying data may be available on 1,231 other members of the group, and these data have been requested. In addition we are currently seeking from the St. Louis Records Center the last known address, date of birth, and social security number on the remaining men for whom the VA had no data. I might add that until now, the system has been passive, hoping people will report because they have read about the study in the media. Once we have the last address, we can begin an active system of going after names where we now have no information.

Mr. **Florio**. Doctor, you are talking about a total population of 3,153 people. Is that list you have, purported to be comprehensive of everyone who was there?

Dr. **Foege**. For Army personnel at Smoky.

Mr. **Florio**. For Smoky.

Dr. **Foege**. For Army personnel at Smoky only, not for other tests.

On December 1, 1977, DOD invited DOE, VA, and CDC to a meeting at the Pentagon to discuss future approaches to studying the possible health effects of exposure to nuclear tests. The participants discussed the possibilities of a broad-based mortality study. The National Academy of Sciences—National Research Council Follow-Up Agency, which was also represented at that meeting, agreed to develop preliminary research protocols. At the same time, the studies initiated by CDC specifically with respect to Smoky will continue.

Follow-up data for persons present at Smoky are still far from complete. While eight cases of leukemia—five acute leukemias and three chronic myelocytic leukemias—have been identified among military personnel, expected leukemia incidence in this cohort can as yet only be approximated. This is because incidence and mortality rates for cancer and leukemia vary greatly by age, and we have yet to determine the exact ages of persons present at Smoky. Such information was not available on the Army's list of 3,153 men. Assuming that the great majority were around age 20 in August 1957, we can calculate that roughly two cases of leukemia might be expected to have occurred among these men since that time, based on rates from the National Cancer Institute's third national cancer survey. If this assumption of the denominator is correct, then the finding of eight cases of leukemaia would be unusual. If ages were older, however, the estimate of expected incidence could be considerably higher. For instance, if the average age was 32, the expected number of cases would double. If in addition it is found that some of the eight cases had other radiation exposures, such as exposure to multiple tests, the number of cases related only to this exposure would be reduced. It is therefore premature to judge whether the eight cases observed are truly excessive, or only apparently excessive.

Several tasks remain to be completed in the immediate future.

One, death certificates are being obtained through the VA and must still be reviewed.

Two, current cases of leukemia must be identified, and clinical and personal history details of all cases must be reviewed by examining medical records, and through contact, if possible, with patients or their surviving families.

Three, the age structure of the group present at Smoky must be better defined, either through data linkage with record files in which such information exists, or through individual tracing of each member of the group. While VA records may be of partial help, ultimately it may be necessary to trace specific individuals. CDC staff continue to work on this latter approach.

If leukemia is shown to be related to the exposure of personnel at Smoky, the Department of Health, Education, and Welfare would have an obvious interest in a comprehensive review of the risks involved with low-level radiation. That would require additional HEW studies or an active role in planning and carrying out the mortality study currently under development by the NAS–NRC Follow-Up Agency.

In any event, in planning and carrying out broader studies the following conditions should be met:

The studies must be established so that they are conducted as objective, sound, and scientifically independent studies; if results from the Smoky study confirm increased risk, broader followup studies must be conducted with highest priority and with adequate funding guaranteed in the beginning; the scientific protocols, prior to implementation, should reflect a consensus of the best scientific judgment of the agencies involved; independent and continuous scientific oversight of the studies should be conducted as they progress; and the final interpretation of data should result from an objective and comprehensive analysis of the data.

This is a brief summary of the status of the Smoky study, Mr. Chairman, we would be happy to answer questions that you might have.

Mr. ROGERS. Where does the roadblock exist in getting the proper records?

Dr. FOEGE. I think the first problem was one of time, the 20 years that had elapsed from the study until we began looking.

Second, we had some difficulty determining which units were involved; and third, finding which individuals were present in those units. Now we do know the individuals' names.

But we have problems with the linkage of records in general because even though we have names and serial numbers, we do not have the present addresses and ages at this point. The ages are important if we are to determine what we would expect in this group.

The Privacy Act has caused some problems. It has come up every time we have talked to another agency, and I think appropriately so. People have to be thinking in terms of, "Is this a violation of the Privacy Act?" It is my feeling that the other problems, record systems in general, have been greater roadblocks, greater handicaps than the privacy issue.

Mr. ROGERS. Well, I think for an epidemiological study, certainly, first, the Privacy Act should be no impediment. If it is, you ought to let us know.

Dr. FOEGE. We will.

Mr. ROGERS. Who is raising the question that they cannot give you the records because of privacy?

Dr. FOEGE. I think every agency has raised the question and resolved it in some way. At the present time we have asked the VA, for instance, for the records on the other 1,300 men, and they are checking to see that there would be no violation of the Privacy Act. They have assured us once that is done, they will provide us with that information.

Mr. ROGERS. Well, how long does it take them to decide that; did they tell you?

Dr. FOEGE. We are expecting that information very soon. I think in fact that we are on the verge now, within the next several weeks, of getting much of the information that we have been after.

Mr. FLORIO. If the gentleman would yield?

Mr. ROGERS. Yes.

Mr. FLORIO. I am just astounded that something as innocuous as the ages of 3,000 servicemen cannot be provided to you in an afternoon. That information is on the face of the service jacket, and if you get on the phone today, it seems to me, it is something that someone should be able to provide you without any difficulty.

Dr. FOEGE. I think the problem really is that the record that will show the age can only be accessed if one has a social security number, which one has to get from a different record. So, it is not simply available at one place, there have to be cross-linkages. I think that is where we have the problem.

Mr. ROGERS. Would you set forth in writing for us the exact steps you are taking, where you have received a denial, and on what grounds? Will you submit that for the record, and I would like that done by tomorrow. We will call those agencies and try to get that straightened out. That is absurd, not to be able to get records for an epidemiological survey. We are not going to make these records public or invade anyone's privacy here, nor does the privacy law anticipate that you could not do an epidemiological health study. So, we would like to have that furnished to the committee immediately.

Dr. FOEGE. We will do that.

[Testimony resumes on p. 209.]

[The following information was received for the record:]

RESOURCES FOR EPIDEMIOLOGIC INVESTIGATION OF 3,153 MEN
EXPOSED TO ATOMIC NUCLEAR RADIATION
AUGUST 31, 1957

I. ARMED FORCES RADIOBIOLOGY RESEARCH INSTITUTE

Information Requested	Date & Type of Request	Reply	Date & Type of Response	Remarks
Check on Radiation recordings of 10 individuals that participated in Nevada, 1957, blast & present location. Information about Operation. Number of other people involved.	Letter 2-24-77	Surgeon General of each service was supplied dosimetry & identifying data in 1964 on each individual involved in 1957 atomic detonations. Suggest check with Surgeon Generals. No planned followup. Requested name, service no., social security no. of 10 individuals.	Letter 3-24-77	At this time CDC knew names, rank, & serial numbers of only 10 men involved.
Review records on 10 and others from 504th and 82d who were present at blast for last known addresses - list sent.	Letter 4-6-77	Names of 82d provisional company and radiation doses in general. Will forward other names when list assembled.	Letter 6-15-77	Radiation doses and serial numbers not provided because of privacy act.
Need official tally and list of units for 1953 tests. List of Canadians present at blast.	Letter 6-13-77	No tally or unit list for 1953.	Phone	List of Canadians not provided because of privacy act.
Serial Numbers of 82d.	Letter 7-8-77 & phone call	See Section on Surgeon General letter of 8/19/77.		

II. SURGEON GENERAL OF THE ARMY

Information Requested	Date & Type of Request	Reply	Date & Type of Response	Remarks
Names of all personnel present at Smoky (8-31-57) with service no., social security no., birth date, all available addresses, and any other identifying data. Individual dosimetry data, all units present at test, unit position at time of detonation. Fallout and radiation levels at points where various units were positioned.	Letter 4-25-77	Armed Forces Radiobiology Research Institute (AFRRI) to be lead agency in developing requested information. Department of Army staff collaborating to review entire test series.	Letter 5-17-77	May take several mont Confirmation of security clearance of CDC staff required.
Need names and serial numbers as rapidly as possible. CDC activity would not involve classified data.	Letter 5-31-77	AFRRI will furnish roster of participants when compiled.	Letter 6-27-77	
Inquiry about Smoky list status.	Phone 8-17-77 8-18-77	Surgeon General furnished list of 3,153 names, serial numbers, rank, & radiation dose. Reason, medical expediency.	Letter 8-19-77	Some internal (SG) problems with privacy act. phone - 8-17-77 and 8-18-77.

III. DEPARTMENT OF DEFENSE

Information Requested	Date & Type of Request	Reply	Date & Type of Response	Remarks
List of participants, units, or other information about nuclear test Smoky - August 31, 1957. Requested of following:				
H. Bragg, HQ 504th Airborne	Phone 3-24-77	No data.		
HQ 82d Airborne	Phone 3-24-77	No data.		
Historical Office	Phone 3-24-77	No data.		
Pentagon Archives	Phone 4-6-77	No data - call National Records Center, Washington.		
National Records Center	Phone 4-6-77	No data - call Adjutant General's Office.		
Adjutant General's Office	Phone 4-6-77	Will check and call back.		
Surgeon General's Office	Phone 4-6-77	Called for Adjutant General. Will check.		See section on contact with Surgeon Genera
Do any of 10 men known to CDC have a malignancy? Requested of Brook Army Tumor Register.	Phone 4-6-77	Names not listed in tumor registry.		
Who has files of discharge/separation papers? Requested of DOD Public Information Office.	Phone 12-77	St. Louis Record Center, not retained by DOD.		

IV. ST. LOUIS MILITARY RECORD CENTER

Information Requested	Date & Type of Request	Reply	Date & Type of Response	Remarks
Identify men present at nuclear test on August 31, 1957.	Phone 3-24-77 3-30-77	No - call VA Liaison (see Veterans Administration)		Need identifiers. Confidentially, privacy act, or records lost in fire.
If provided name and serial number, can birth date, social security number, last known address and other information be retrieved?	Phone	Maybe, bring list for trial run.		May need formal request for release. Records may not be available because of fire.
Do trial run using Smoky list to see if locating information available.	Visit to Center by 2 CDC staff 1-25 & 26-78	Trial run successful. Usable identifying information on some individuals available. No barriers to acquisition of data.		Only problems anticipated are lack of identifiers and burned files. The next step is the Reserved record file system. Contact made 1-25-78 and acquisition ensured on available data.

V. VETERAN'S ADMINISTRATION

Information Requested	Date & Type of Request	Reply	Date & Type of Response	Remarks
Identify Smoky participants. Requested of VA liaison St. Louis Record Center.	Phone 3-20-77	No - call VA Central Office.		
Same question asked of Department of Research.	Phone 3-30-77 3-31-77	No - request official study through National Research Council.		If privacy act permitted release, they would need the serial no. and/or social security no. as identifiers.
Same question asked of VA. Requested of Central Office.	Phone 4-13-77	No.		Would need formal request with identifiers and may have problems in relation to privacy act. No formal request made due to lack of identifiers.
Identify all veterans on the Smoky list who have died and provide death certificates. Requested of VA Central Office.	Phone Letter and list 11-16-77	Will try.		
Identify all veterans' addresses on Smoky list known to VA; identify those who are dead and provide death certificates.	Visit to VA 12-1-77	Seeking legal opinion for release of data on living. VA will compile list of dead as soon as possible.		May need additional identifiers. Not all veterans applied for benefits. Question release of information on living veterans under privacy act.

V. VETERAN'S ADMINISTRATION (Continued)

Information Requested	Date & Type of Request	Reply	Date & Type of Response	Remarks
		Computer list of veterans both alive and dead & those with no known VA record compiled from Smoky list. Death certificates to follow. 80 death certificates received as of 1-28-78.	Letter & list 1-3-78	
How soon can we get more identifying & locating data on living vets? DHEW listed as routine user of VA in regard to Privacy Act.	Letter 1-17-78	Will attempt to get data as rapidly as possible.	Phone 1-26-78 Letter in mail	

VI. DEPARTMENT OF ENERGY

Information Requested	Date & Type of Request	Reply	Date & Type of Response	Remarks
First cancer case made known to CDC (11/26/76) by VA physician (former CDC employee). Individual alleged presence at atomic bomb tests in 1958 (was 1957). Enquiries initiated to ERDA and Los Alamos Laboratory.	Phone 11-76	Radiation doses at blasts not hazardous.		Can only help if nam & identifiers know cannot identify me from date or unit alone.
Confirmation as to whether 22 individuals known to CDC were present at Smoky. Requesting dates present at test site, location at test site, employer if civilian, and radiation doses.	Phone 10-18-77 Letter & list 10-20-77	Radiation dose and year exposed.	Forms 11-21-77	Privacy Act, need to send record releas for each name. Phone 10-18-77. Some gaps in data.
Test bone sample for radiation (one individual).	Letter 11-17-77	No increased radiation. Need larger sample.	Phone 12-12-77	
Do radiation exposure records have precise dates of exposure?	Letter 11-21-77	No reply.		

VII. SOCIAL SECURITY ADMINISTRATION

Information Requested	Date & Type of Request	Reply	Date & Type of Response	Remarks
Can Military Serial Number be cross-linked with social security number?	Phone 1-24-78	No, but method of obtaining social security number possible if other identifiers known.		Will need formal request. Request will be made.

VIII. NATIONAL ACADEMY OF SCIENCES

Information Requested	Date & Type of Request	Reply	Date & Type of Response	Remarks
Any data available on U.S. tests? Any way to identify men present at Smoky?	Phone 2-17-77	No, data on U.S. tests, suggest contact - AFRRI.		See section on AFRRI

IX. NATIONAL CANCER INSTITUTE

Information Requested	Date & Type of Request	Reply	Date & Type of Response	Remarks
Does NCI have registry of cancer cases in people exposed to nuclear tests? Who does have a registry?	Phone 4-4-77	No studies done by NCI. Contact Brook Army Tumor Registry.		See section on DOD.

Mr. ROGERS. Now, you said if the men were 32, the cancer rate might double, which would be 4 cases in 500.

Dr. FOEGE. That is right.

Mr. ROGERS. But now you have found eight cases.

Dr. FOEGE. That is right.

Mr. ROGERS. But you still give a rather qualified answer which surprises me, that there is some question, still.

Dr. FOEGE. What I can do, Mr. Chairman, is tell you how I think I have to approach this as a scientist, and then give you my personal opinion, if this would be helpful.

Mr. ROGERS. Yes.

Dr. FOEGE. I think as a scientist we have to say that these eight people may have had other exposures that explain why they are in the numerator. Three of them, for instance, are living. We have interviewed them, and we have found that all three have been in other tests, also. So, it is very difficult to say that this is the only exposure they have had.

It also requires that one has to get the medical history to find out, what have they had in the way of X-rays through their lives; whether there have been occupational exposures to radiation. This has to be done before we know that the cases are firm and can be related to Smoky.

The other problem, of course, is the denominator, knowing the age of the 3,000 plus participants. And for scientific reasons, I think, we have to say that this has to be firm before we say this is statistically related.

My personal opinion would be that when you have eight cases, one has to go on the assumption that this is out of the range of normal. With that assumption, we have to proceed with other tests, and pull back only if subsequent tests show that it is not abnormal, that it is not out of the range of the expected.

Mr. ROGERS. What were the ages of the three men you personally interviewed, at the time of Smoky?

Dr. FOEGE. The present age would be 42——

Mr. ROGERS. No; the ages at the time it occurred.

Dr. FOEGE. The time of Smoky? It would be 22, 24, and 39. So, there is an age range of people, even in this small sample.

Mr. ROGERS. Yes, Dr. Carter?

Mr. CARTER. If you would yield on that please. Two of the three living leukemia victims at least are now in the 40 to 44 age range. And, I would ask you, what is the average incidence of leukemia in that group?

Dr. FOEGE. In the 40's——.

Mr. CARTER. Age 40 to 44.

Dr. FOEGE. 40 to 44.

Mr. CARTER. And assuming most of those men who were at Smoky are now in that age group.

Dr. FOEGE. The expected incidence would be 4 cases per 100,000 per year.

Mr. CARTER. 4.1, I believe, to be exact.

Dr. FOEGE. That is right.

Mr. ROGERS. So, even if some of the participants are older, the eight cases you now have would represent a doubling of that factor?

Dr. **Foege**. This, of course, is an incidence per year, and we are looking at a cumulative of 20 years. So, one would have to take this times 20.

Mr. **Rogers**. And this is for how large a population, for 100,000?

Dr. **Foege**. For 100,000 population, that is right.

Mr. **Rogers**. And in this we are talking about 500.

Dr. **Foege**. In this we are talking about 3,000 people.

Mr. **Carter**. If you would yield on that, if you would, sir.

Mr. **Rogers**. Yes.

Mr. **Carter**. Actually there are only 447 men who have been located; is that correct?

Dr. **Foege**. That is right.

Mr. **Carter**. And out of that 447 you have 8 cases—8 cases. All right. Now, you say that is not statistically significant. If we assume the same ratio for the 3,153, that would be a total of 56.6 cases. Now, what about that, is that within the normal range, 56.6 for 3,153?

Dr. **Foege**. That would of course be far out of the normal range.

Mr. **Carter**. All right. Now, let us project this still further. If we assume 100,000 men were involved in the tests do you know how many of those people would have leukemia at the rate found so far for Smoky?

Dr. **Foege**. If we used your figures——

Mr. **Carter**. I am not using my figures, I am using the incidence for Smoky thus far and extrapolating that by ratio and proportion.

Dr. **Foege**. There is a problem with that, Dr. Carter.

Mr. **Carter**. Bear with me for a moment. At the same ratio as found for Smoky to date, what would be the incidence for 100,000?

Dr. **Foege**. With that figure it would be about 1,500.

Mr. **Carter**. I calculate it to be 1,796, at the same ratio.

But I certainly want to commend your department for its work, and particularly Dr. Caldwell for his work in this, Dr. Foege; it is very good.

Thank you, Mr. Chairman.

Mr. **Rogers**. Thank you.

Dr. **Foege**. If I could mention, Mr. Chairman, the problem that we have had with this—and it would be nice if we could extrapolate them that way—the problem is that we think the numerators, the deaths, have probably come to our attention faster than the denominators. For instance, we think we now have over 90 percent of death certificates from this group. So, you cannot make an exact proportional change from the 447 to the 3,000.

Mr. **Rogers**. Dr. Caldwell, you are an epidemiologist. Does it have any significance that you have found more than six cases?

Dr. **Caldwell**. Certainly, in a group this size, if their ages were 22 to begin with, and we followed them for the full 20 years, one would expect—if they are the same as the rest of the U.S. population—two cases over 20 years. At this point we have found eight, that is high. The only other alternative we have to look at is whether or not the age of the population under study is an older age group. And at the same time you have to see if they have other risk factors. Is it possible that they were at many bomb tests? Some of the fellows we know were at more than one test, but we do not always know whether they were there at more than 1 year.

The other possibility is that they may have other risk factors, particularly, what is their occupation. Chemists, radiologic technicians, et cetera, may have higher incidence rates. It is entirely possible there is a genetic component, and we have to know whether or not they came from multicase cancer families. We are seeking all of this information now. You have to do that by interviewing the patients.

Mr. ROGERS. But even if the ages were 40 to 44, the eight cases that you found, what would that tell you?

Dr. CALDWELL. If the average age of this group happened to be over 40—let us say 42—eight cases would be what one would expect on an age basis. As you grow older your risk for disease is higher, particularly for leukemia and cancer.

Mr. CARTER. Mr. Chairman?

Mr. ROGERS. Yes, Dr. Carter?

Mr. CARTER. I want to thank Dr. Caldwell for his wonderful work, but in the last few weeks I have seen a little change in this, a little shifting and perhaps a little waffling. I was told that seven would be statistically significant.

Mr. ROGERS. That is what I understand.

Mr. CARTER. And now we not only have seven, but we have eight; and we are still not being told this is statistically significant.

Mr. ROGERS. Well, I was under the impression that seven would be a most significant number, and that six would be on the borderline. I believe you were quoted as saying that, Dr. Caldwell. And that over that it would be very significant. Was that your thinking for a while, Dr. Caldwell?

Dr. CALDWELL. Six, I believe, would be significant if the age structure is such that 22 is the average age. I think a peice gets left off all the time, you have to take into account the age of the population involved.

Mr. ROGERS. I presume most men went into the Army at a rather younger age, but we will find that out. Yes, Dr. Foege?

Dr. FOEGE. Mr. Chairman, I will repeat that seven is a significant number. The probability is 0.001, which means that we would expect to have seven or more cases only once in a thousand times by chance. So, I have no problem with saying that is a significent number. The only caveat we put on this is, if our assumptions are correct and we can prove them. Once we have a list of ages for these men, we can within a period of 3 or 4 days calculate the true expected rate.

So, I still have no problems with saying seven or eight is a significant number if our assumptions turn out to be correct, and we have no reason to believe they will not.

Mr. ROGERS. And you expect to get—and we will help you get the ages of the men involved, if it is necessary. You expect them, you said, within 2 or 3 weeks?

Dr. FOEGE. We are hoping that these will come in very rapidly.

Mr. ROGERS. Well, you are going to give us this information and we will see if the committee cannot be helpful in getting these ages, so we can make a quick determination.

Have you seen an increase in malignancies or any other problems in health that might be associated with radiation?

Dr. FOEGE. The information we have now, in addition to the leukemias, shows 29 cancers. But this falls within the expected at this point because we would expect in excess of 40. However, again, the information is so imcomplete that we cannot say we will not see an increase.

Mr. ROGERS. What age does that 40 go to, 20, 22?

Dr. FOEGE. This was on the basis of 22, that is right. If the average age was 22, we would have 40 cases of cancer.

Mr. ROGERS. What about malignancies from all of the tests that you looked at, not just Smoky?

Dr. FOEGE. We have had in our response to the newspaper articles—I should say first of all, that thousands of letters have been received—in addition to the 447 that we can relate to Smoky, about 1,300 other people have told us about their being at another test. In that group we have found 52 leukemias and 211 other cancer cases. However, these still also fall within an excepted range, so that we do not have anything unusual in these other tests. But again, that is not a systematic look and we would not expect something unusual at this point.

Mr. ROGERS. But that will be developed as we get the additional facts?

Dr. FOEGE. The Smoky test will be developed completely, and then, on the basis of the additional studies, some of these will be included, and some will not. I think a determination will have to be made on how to randomly select other tests and follow cohorts of men from those tests, looking for leukemia and cancers.

Mr. ROGERS. Yes. Are you familiar with what is being done to trace those in Japan, who were exposed to the radiation of the bombs dropped?

Dr. FOEGE. We are familiar with the studies, yes.

Mr. ROGERS. Are they checking all of the people, or do they do a random sampling.

Dr. CALDWELL. If my understanding is correct, at Hiroshima and Nagasaki they were able to identify shortly afterwards the individuals who were present within the city limits at the time of the nuclear detonation. They were also able to identify to some extend people who came in later. So, they have been following them for all these years, where in our situation we have to now go back and find them. It is only slightly different.

Mr. ROGERS. But it is my understanding you might not anticipate finding these people, is that what you are saying? Or, even if you found them, you would not necessarily include them in the test?

Dr. CALDWELL. No; what I am saying is, they knew who was exposed and have followed them for 20 years.

Mr. ROGERS. Yes.

Dr. CALDWELL. We are now going back trying to identify who was there, 20 years later.

Mr. ROGERS. I understand, but are you telling me you do not think we can identify who was there, now, even though we have the Army records and the units involved?

Dr. FOEGE. For Smoky we will be able to identify the people who were there; and we should be able to, on a large percentage, get followup information on Smoky.

Mr. ROGERS. But you would include all the people that could be identified.

Dr. FOEGE. On Smoky we will, that is right.

Mr. ROGERS. But I mean in the others.

Dr. FOEGE. In the other test, once we have the information on Smoky, the other tests, I think will have to be followed the same way, that selected tests will be taken and cohorts totally followed from those tests. We will use all the information we have, but we may not have a statistically significant group of people from any individual test.

Mr. ROGERS. Have you received reports of birth defects which might indicate genetic damage among children of any of the test participants; or have you looked at that?

Dr. CALDWELL. We have not specifically looked at that. There have been occasional people who indicate they may have a problem with their children. This would come under the portion of the study we would proceed with after this. After you identify everybody, you can then ask these questions in a systematic way. At the present time we are trying to identify the cohort to determine the cancer incidence, and then go on to do the next step because you have to know everybody for those.

Mr. ROGERS. How many specific cases of possible genetic damage have been claimed, or identified?

Dr. CALDWELL. I do not know exactly.

Mr. ROGERS. About?

Dr. CALDWELL. At least three individuals that I can think about have claimed they have some problems with their children. I have not followed those up consistenly.

Mr. ROGERS. Have any agencies not cooperated in the study, or made the study more difficult?

Dr. FOEGE. As far as we can tell, Mr. Chairman, when we have asked for materials, if the agencies have had the information, they have given it to us. I think, though, they have difficult problems with the record systems.

Mr. ROGERS. The Radiological Section in the Department of Defense would have to have the name of each individual, and asked you to furnish that; is that right?

Dr. FOEGE. Originally they asked for names. But when we were able to provide units, they then came back with the individuals in those units.

Mr. ROGERS. They could not find out in the Department of Defense what units were involved, you had to do that?

Dr. FOEGE. I am sure they could have found out.

Mr. ROGERS. It is unbelievable they could not have found out what units.

Mr. CARTER. Mr. Chairman?

Mr. ROGERS. Yes, Mr. Carter.

Mr. CARTER. Perhaps my own work trying to help a constituent of mine who has leukemia might be of interest at this point. Mr. Donald Coe first was told that there were no records showing he was exposed to radiation or treated for radiation sickness. We were able to place him at Camp Desert Rock through his morning reports and then to get his film badge records. After obtaining Mr. Coe's medical records through the Veterans' Administration, we were surprised when he was told by the St. Louis records center that those medical records were burned in the 1974 fire.

That is the way that information thing goes with our wonderful military personnel. I think many of them are great, but their recordkeeping lacks just a little bit, as I see it.

Mr. ROGERS. May I ask you this, has the Department of Defense ever funished you a complete list of all of the units involved in Smoky?

Dr. CALDWELL. With the list of 3,153 men they also identified the units; yes, sir.

Mr. FLORIO. Mr. Chairman?

Mr. ROGERS. Yes.

Mr. FLORIO. I noticed in your testimony you said that from varied sources you were able to obtain these lists of units. Were any of these varied sources the Department of Defense?

It seems to me the logical thing would be to go to the Department of Defense, ask them for the list of the units, and they would provide it to you, or should have. The implication, is that you got it from some place else, and then went to the Department of Defense and they gave you the names of the people who were in those units. Which case is it?

Dr. CALDWELL. I got the original list from elsewhere.

Mr. FLORIO. From where?

Dr. CALDWELL. I originally received this from a subcontractor, General Electric, from a computer source called DASIAC. I called the gentleman out there and asked him if he had a copy, and he sent it to me.

Mr. FLORIO. Mr. Chairman, the observation is astounding. Looking through the testimony and listening to you, you had to rely upon random telephone inquiries, responses from a magazine article, and then lists supplied from individuals other than the logical persons to get the list from.

Do you have any other studies that you are conducting, that involve the Department of Defense?

Dr. FOEGE. I cannot think of one that is comparable, that is going back 20 years looking for data. We do have other studies following up the effects of vaccines in troops, and so forth. But I cannot think of anything that is comparable.

Mr. FLORIO. On those other studies, did you get the same degree of cooperation that you received in this type of thing?

Dr. FOEGE. I think we have always had cooperation when we know to whom to go, and when we know what information we need. Perhaps part of the problem here was the difficulty of getting in any one place everything we wanted on an individual.

Mr. FLORIO. My observation is just, you should not be the one to collate all the information. In fact, you are to be commended for your detective work in seeking out some of these people to provide you the information. It seems to me, you have been at work—according to your testimony—since 1976, when this was first brought to your attention. You should be much farther along.

Apparently, not because you did not do what you were required to do, but because other people who perhaps did not make things as available to you as they could have with a little bit of effort on your part.

The previous speaker made reference to a list of 200,000 people at DOE. What do you know about this list, and are you attempting to get this list?

Dr. FOEGE. We have been told that there are perhaps 200,000 military personnel who have been exposed to various nuclear tests. We are told that this list will be used in developing the second phase of the study in randomly selecting the nuclear tests that will be tested by us, or by people doing these secondary tests. So, that information should be available. We do not have it now, but we have not asked for it because we have been trying to do the Smoky part of it.

Mr. FLORIO. Well, if the list is available I assume that part of the universe of 200,000 includes the Smoky 3,000. Someone has had the list, and I am just not sure why you had to go to those devices of going out to contractors to get the names, if in fact the list was available.

Dr. FOEGE. I think the knowledge of the 200,000 and so forth, has been subsequent to our initially working on Smoky and getting the information on individuals.

Mr. FLORIO. Thank you, Mr. Chairman.

Mr. ROGERS. Well, as I understand it, then, did you make any inquiry of the Department of Defense to give you the names or give you the units, and they said they could not, before you got them from General Electric?

Dr. CALDWELL. We had originally asked, I think it was on February 24, we asked for this type of information from the Armed Forces Radiobiology Research Institute, our contact with them. We received part of the list later on, and we received the last of the list this August 19.

Mr. ROGERS. But you had already identified, before you got information from them, the units, and gave them the list of the units before?

Dr. CALDWELL. I gave them the list of the units.

Mr. ROGERS. Even though you had asked them for it.

Dr. CALDWELL. Yes.

Mr. ROGERS. And they did not furnish it until after you had gone out and gotten it from the contractor, who had been present.

Dr. CALDWELL. Yes, sir.

Mr. ROGERS. That is unbelievable. Well, this emphasizes my concern to allow a study to be done by the Department of Defense, Department of Energy, or the VA, in this instance, where you had roadblocks thrown up. Where the Department of Defense has not come forward to help in the study, but you had to get your information from other studies before they even gave information to you which they had available to them. The VA is now putting up the Privacy Act as a possible block, even though men's lives may be involved.

Well, this committee appreciates what you are doing. We commend you. We want to see you continue to work on this. It is unbelievable to me that this exists in our Government, and this committee is going to get to the bottom of it, we are going to change that. We will hear from witnesses from the Department of Defense, Department of Energy and VA, and I am sure, if we have to pursue it farther than that, up to the Secretarial level, the

White House, on the floor of the Congress. We will assure that it will not be difficult to make proper studies to see if American soldiers, who were exposed in tests and absorbed radiation from them and are now suffering injuries, and have never been told about the possibility.

I commend the CDC for the work it is doing, it is most helpful.

Mr. FLORIO. Mr. Chairman?

Mr. ROGERS. Yes.

Mr. FLORIO. Was the December 1 meeting, the first indication of interest on the part of the various agencies involved in proceeding in a more comprehensive way? Do you know what was the motivation, as to why that meeting took place then, what was the impetus for the meeting?

Dr. CALDWELL. I had met with members of the Armed Forces Radiobiological Research Institute in August. At that point in time the Walter Reed Army Institute of Research was looking for additional cases. We found two additional cases in the Armed Forces Institute of Pathology, and discussed what other possible means we might take to study the problem. Later on they decided to have the December 1 meeting with the idea that maybe we could develop another study that would complement the one we were already doing.

So, this was not the first time, as far as I know, that they had considered it.

Mr. FLORIO. Thank you, Mr. Chairman.

Mr. CARTER. Mr. Chairman, might I inquire?

Mr. ROGERS. Certainly, Dr. Carter.

Mr. CARTER. To get back to the issue of disease incidence, I believe you stated that you have a total of 1,300 men from all the tests, the names of those men. Is that correct?

Dr. FOEGE. That is right.

Mr. CARTER. And of that number, how many have cancer of any form?

Dr. FOEGE. 211 have cancer, and 52, in addition to that, have leukemia.

Mr. CARTER. How many?

Dr. FOEGE. 211 have cancer other than leukemia, and 52 have leukemia.

Mr. CARTER. 251 have cancer——

Dr. FOEGE. 211 have cancer, and 52 have leukemia.

Mr. CARTER. Fifty-two have leukemia. So, 52 out of 1,300, that would be roughly 4 percent; is that correct?

Dr. FOEGE. That is right.

Mr. CARTER. That would be 40 out of 1,000; 400 out of 10,000; 4,000 out of 100,000, and 40,000 out of 1 million. That is quite an incidence there, is it not?

Dr. FOEGE. We again have the problem that people who have leukemia and cancer who were the ones likely to write.

Mr. CARTER. Yes, sir. But do you find that significant, that percentage of these men having leukemia?

Dr. FOEGE. The number of cases of leukemia that could be expected in the entire universe—whether it is 100,000 or 200,000—would be greater than this. But we have so little information——

Mr. CARTER. Well, granted that, I submit that, per unit, you would not expect 4 people out of 100 to have leukemia, would you?

Dr. FOEGE. Not on a random sampling, no, sir.

Mr. CARTER. In addition to leukemia you said you have 211 cases of cancer out of the 1,300 who have contacted you. Do you take that to be significant or not, in this particular age group?

Dr. FOEGE. We would have expected more cases of cancer than that in the entire group. And again, we have the problem of knowing, did the proportion of people who had cancer report out of proportion when they saw this in the newspaper. So, did we in fact get a concentration of these people.

Mr. CARTER. Yes, sir, that is possible. Certainly, I want to commend you on your work, but I feel that you definitely have proved a statistically significant number of leukemias already. Without a doubt I believe that is true.

Dr. CALDWELL. I think we certainly have the suspicion that this is high, eight cases of leukemia are out of bounds, as we know it. Until we have analyzed the whole cohort, I hesitate to use the word "proved," but I would not dispute the possibility.

Mr. CARTER. You would say it is statistically significant; is that correct?

Dr. CALDWELL. At this point; yes.

Mr. CARTER. Thank you, sir.

Mr. ROGERS. Mr. Florio?

Mr. FLORIO. Mr. Chairman, just for the record, I inquired a few moments ago about the motivation for the meeting of December 1. I have a memo to the Deputy Assistant Secretary of Defense on the subject of atmospheric nuclear testing and possible long-term medical consequences. The memo reads in part:

> There has been considerable media exposure on this matter to date. Two network television news teams have acquired extensive film footage and have conducted lengthy interviews with those involved. The media position apparently is to wait and see when and how the agencies involved will respond. If we do not respond appropriately, we can expect to have the same kind of adverse publicity as that experienced in regard to the asbestos problem.

It seems to me this is hopefully not the prime motivation, although, to be perfectly frank, from what you have indicated to us today with regard to the difficulties you have had in getting information, and with the delays that were taking place, I think it would be particularly unfortunate if it is found out that this seems to be the main impetus behind the efforts that have gone on up to this point.

To a certain extent I suppose the Chairman and Mr. Carter deserve an awful lot of credit for moving in this area so as to get things underway, at the same time I think it is particularly unfortunate that that is what has to be done to get agencies to convene meetings and start distributing memos. Thank you, sir.

Mr. ROGERS. We will take that up with the Department of Defense this afternoon when we will have witnesses from the Department of Defense, Department of Energy, and from the Veterans Administration.

The committee will stand in recess until 2 o'clock. Thank you for your presence.

[Whereupon, at 12:40 p.m. the subcommittee recessed, to reconvene at 2 p.m., the same day.]

AFTER RECESS

[The subcommittee reconvened at 2 p.m., Hon. Paul G. Rogers, presiding.]

Mr. ROGERS. The subcommittee will come to order, please. We will continue our hearings on the health effects of ionizing radiation.

Mr. Coe wants to appear this afternoon, he was being flown up from Nashville; but it is my understanding that the airport is fogged in and he will not be able to arrive today. I think he is there at Vanderbilt Hospital.

Mr. CARTER. That is correct.

Mr. ROGERS. So, whenever his schedule permits the committee will make an effort to hear his testimony.

So, we will continue this afternon with the witnesses from the Department of Defense, the Deputy Director for Science and Technology, Mr. Peter H. Haas, Defense Nuclear Agency; Maj. Alan Skerker, who is a member of the Nuclear Division, Strategy, Plans and Policy Directorate, Office of the Deputy Chief of Staff, Operations and Plans, U.S. Army, and Col. Darrell W. McIndoe, who is Director of the Armed Forces Radiobiology Research Institute, National Naval Medical Center.

We welcome each of you gentlemen to the committee, we appreciate your being here. Your statements will be made a part of the record in full without objection. You may proceed.

STATEMENTS OF PETER H. HAAS, DEPUTY DIRECTOR, SCIENCE AND TECHNOLOGY DEFENSE NUCLEAR AGENCY, DEPARTMENT OF DEFENSE; COL. DARRELL W. McINDOE, M.D., DIRECTOR, ARMED FORCES RADIOBIOLOGY RESEARCH INSTITUTE, NATIONAL NAVAL MEDICAL CENTER, DOD; AND MAJ. ALAN L. SKERKER, MEMBER, NUCLEAR DIVISION, STRATEGY, PLANS, AND POLICY DIRECTORATE, OFFICE OF DEPUTY CHIEF OF STAFF FOR OPERATIONS AND PLANS, DEPARTMENT OF THE ARMY, DOD

Mr. HAAS. Thank you, Mr. Chairman.

Mr. Chairman and members of the subcommittee, I am Peter Haas, Deputy Director, Science and Technology of the Defense Nuclear Agency. DNA is acting as the Department of Defense's action agency on the investigation of the possible effects of this Nation's atmospheric nuclear test program on participants for several reasons.

First, DNA is derived from the Armed Forces special weapons project, later known as the Defense Atomic Support Agency. AFSWP participated with the Atomic Energy Commission in the conduct of most of the military tests. We furnished military officers to the AEC to serve as deputies to both the test manager and test director. AFSWP also coordinated between the Military Services and the AEC for the troop tests, such as shot Smoky.

Mr. ROGERS. Excuse me, could you pull the mike a little closer to you? It may be that the other one works better. One of those is not working. I do not know which one works, you might see. I think that is the one. Thank you.

Mr. HAAS. I myself worked at the Nevada test site during the Plumbbob test series and have been involved in the scientific and technical aspects of nuclear testing since 1956.

DNA also has the expertise to address the medical effects of nuclear weapon radiation. One of our subordinate organizations is the Armed Forces Radiobiology Research Institute charged with the mission of studying the biological effects of ionizoning radiation. With me today to respond to any questions you might have for us on nuclear weapon radiation effects is the Director of AFRRI, Col. Darrell W. McIndoe. Dr. McIndoe is a physician with many years of service as a specialist in internal medicine and in nuclear medicine. Dr. McIndoe has prepared statement which will address your questions on the followup studies that we are organizing on behalf of DOD and other Government agencies. Also with me is Maj. Alan Skerker from the Department of the Army whose statement responds to your questions on the troop tests and radiation safety measures.

Mr. Chairman, we are pleased to have the opportunity to appear before you on behalf of the Department of Defense to assist the subcommittee in its efforts to inquire into the possible relationship between military troop tests during the atmospheric atomic weapons testing program and a potential increase in the incidence of leukemia in the troop participants.

The specific nature of your questions was not received until last Thursday, and therefore we cannot address them all in detail at this time. The data will be provided to you as soon as it is gathered. Today, we are prepared to address the following:

The scope of military personnel involvement on troop tests in atmospheric atomic testing in Nevada and the Pacific.

The sort and types of tests in which military personnel participating in troop tests were involved.

The number of military people involved in these tests, at least approximately.

The uniqueness of these tests relative to Department of Defense and other Government agency relationships.

The radiation exposures of these personnel.

Whether any personnel were "over exposed" and what records might be available on them, and the degree of followup and the nature of our present followup program.

I will now be followed, with your permission, by Dr. McIndoe and then by Major Skerker; then my associates and I are ready to answer your questions.

Mr. ROGERS. Thank you very much. Doctor?

STATEMENT OF COL. DARRELL W. McINDOE, M.D.

Dr. MCINDOE. Mr. Chairman, I am Dr. McIndoe——

Mr. ROGERS. I think we need you to pull the mike a little closer to you.

Dr. MCINDOE. I am Dr. McIndoe, director of the Armed Forces Radiobiology Research Institute. Thank you for allowing me the privilege to present to you the sequence of events which have transpired over this past year concerning the Department of Defense's involvement in an investigation of a potential health hazard to military personnel who were participants in the troop tests during the atmospheric atomic weapons testing program at the Nevada test site.

In February 1977 Dr. Glyn Caldwell of the Center for Disease Control, Atlanta, Ga., called Dr. LaWayne R. Stromberg the previous director of AFRRI and informed him of his interest in pursuing a question of a possible relationship between the development of leukemia in patients and radiation exposure received during an atomic weapons test. Dr. Stromberg agreed to support Dr. Caldwell in his investigations by attempting to retrieve dosimetry readings on the names requested by Dr. Caldwell.

During March and April 1977, considerable interest in the potential problem was raised in the news media, resulting in considerable dialog between Dr. Caldwell, AFRRI, and the Office of the Surgeon General, U.S. Army. Recognizing the significance and magnitude of the questions raised by Dr. Caldwell, and the need for a mechanism to evaluate the problem and mechanically handle the inquiries, the Surgeon General of the Army with the support of the Director, Defense Nuclear Agency, appointed an ad hoc committee with Dr. Stromberg as the chairman to review the possible long-term medical effects of Operation Desert Rock. The committee consisted of the director of AFRRI; Office of the Surgeon General, U.S. Army; Office of the Deputy Chief of Staff for Operations and Plans, U.S. Army; and Office of the Chief of Public Affairs, U.S. Army. The ad hoc committee convened on May 6, 1977 and formulated its goals and approach.

Shortly thereafter, May 13, 1977, an AFRRI representative went to CDC to discuss the problem with Dr. Caldwell and confirm DOD's continued support in his investigations. AFRRI representatives then briefed the Energy Research and Development Administration on May 16, 1977. Groundwork was laid for a meeting at the Nevada operations office in June 1977 to discuss personnel dosimetry records, conduct of rad-safe operations, and ERDA cooperation in review of military troop tests during Operation Desert Rock. The meeting convened on June 3, 1977 with 24 participants representing ERDA, Department of the Army, Navy, Defense Nuclear Agency, and Reynolds Electrical and Engineering Co., Inc. Full cooperation between DOD and ERDA with CDC was agreed upon.

On June 15, 1977, after considerable investigative efforts by Major Skerker, a roster for the Provisional Company, 82d Airborne Division, U.S. Army, was sent to Dr. Caldwell. Individual exposure histories were precluded by the Privacy Act, but the range of exposure experienced was included.

The ad hoc committee had now expanded to include representatives from Surgeon General, U.S. Air Force, Surgeon General, U.S. Navy, and ERDA. Increasing awareness through media coverage of Dr. Caldwell's requests for names of participants at the test Smoky and the response by large numbers of people at many other tests resulted in the committee's recommendation that the military hospitals be apprised of the problem and given guidance in how to respond to the inquiries. On July 11, 1977, a message was sent out from the Office of the Surgeon General, U.S. Army to all medical installations advising them of the problem and instructions in how to respond even if the inquiry came from an individual not eligible for military medical care. A copy of the message can be submitted for the record if you so wish.

Mr. **Rogers**. Without objection it is so ordered.

[The following information was received for the record:]

UNCLASSIFIED

DEPARTMENT OF THE ARMY
PENTAGON TELECOMMUNICATIONS CENTER

CDSN = SCD244 MCN = 77192/07778 TOR = 771921826
RTTUZYUW RUEADWD0513 1921826-UUUU--RUEAPPP.
ZNR UUUUU
R 111555Z JUL 77
FM DA WASHDC//DASG-HCH-E//
TO RUWTNFA/CDRHSC FT SAM HOUSTON TX
RUFDAAA/CINCUSAREUR HEIDELBERG GER//CHIEF SURGEON//
RUACAAA/CDRUSAEIGHT SEOUL KOREA//SURGEON//
INFO RUEFHQA/CSAF WASHDC//SG-SGPR//
RUENAAA/CNO WASHDC//BUMED CODE 53//
RUEBHRA/DIR AFRRI NNMC BETHESDA MD
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UNCLAS SUBJ: PERSONNEL PARTICIPATION IN NUCLEAR WEAPONS TESTING

THE FOL IS BEING PROVIDED FOR INFO AND APPROPRIATE ACTION, INCLUDING DISSEMINATION TO ALL MEDICAL TREATMENT FACILITIES WITHIN YOUR COMD:

A. THERE HAS BEEN A GREAT DEAL OF SPECULATION RECENTLY REGARDING POSSIBLE HEALTH HAZARDS TO PARTICIPANTS IN THE NUCLEAR WEAPON TESTING PROGRAM CONDUCTED DURING THE PERIOD 1946 THROUGH 1958. A NUMBER OF TELEPHONIC INQUIRIES HAVE BEEN RECEIVED IN OTSG FROM MTF'S REQUESTING GUIDANCE ON HOW TO ADVISE AND MANAGE INDIVIDUALS CLAIMING TO HAVE PARTICIPATED IN THIS PROGRAM. AN AD HOC COMMITTEE REPRESENTING THE ARMY SURGEON GENERAL, THE ARMY DEPUTY CHIEF OF STAFF FOR MILITARY OPERATIONS, AND THE ARMED FORCES RADIOBIOLOGY RESEARCH INSTITUTE, HAS BEEN ENGAGED IN A REVIEW OF THE EXPOSURE RECORDS OF MILITARY PARTICIPANTS. THE MAJORITY OF THE EXPOSURE RECORDS AVAILABLE FOR REVIEW HAVE REVEALED THAT DOSES RECEIVED WERE ON THE ORDER OF 50-100 MILLIREM. TO PUT THIS INTO PERSPECTIVE, THE PRESENT FEDERAL STANDARDS FOR RADIATION EXPOSURE ALLOW FOR DOSES OF 5000 MILLEREM PER YEAR FOR RADIATION WORKERS AND 500 MILLIREM FOR INDIVIDUALS IN THE GENERAL POPULATION. THEREFORE, IT IS UNLIKELY THAT INDIVIDUALS EXPOSED TO SUCH LEVELS OF RADIATION HAVE AN INCREASED RISK OF CANCER. PRESENT PLANS ARE TO IDENTIFY THAT GROUP OF PARTICIPANTS WHO MAY HAVE SUSTAINED HIGHER RADIATION DOSES, BASED ON RELATIVE EXTERNAL EXPOSURE LEVELS AND PROXIMITY TO FALLOUT FIELDS. IF WITHIN THIS GROUP THERE IS AN APPARENT INCREASED INCIDENCE OF LEUKEMIA AND/OR OTHER CANCERS, APPROPRIATE MEDICAL FOLLOW-UP STUDIES WILL BE ACCOMPLISHED.

B. ALL INDIVIDUALS, WHETHER ELIGIBLE FOR MILITARY MEDICAL CARE OR NOT, WHO PRESENT THEMSELVES TO ARMY MEDICAL TREATMENT FACILITIES CLAIMING TO HAVE BEEN PARTICIPANTS IN THE WEAPON TESTING PROGRAM, SHOULD BE INTERVIEWED AND THE FOLLOWING INFORMATION OBTAINED:

(1) NAME, CURRENT ADDRESS AND PHONE NUMBER.

(2) THE TESTS IN WHICH THEY PARTICIPATED, UNIT OF ASSIGNMENT AT THE TIME, SERVICE AND SOCIAL SECURITY NUMBERS.

(3) WERE THEY ISSUED A FILM BADGE? DID THEY WEAR THE FILM BADGE?

(4) OTHER FACTS AND CIRCUMSTANCES SURROUNDING THEIR PARTICIPATION THAT THE INDIVIDUAL CAN WRITE IN NARRATIVE FORM, I.E., JOB DESCRIPTION, AND THE OVERALL MISSION OF THE UNIT OR AGENCY.

(5) IF THE INDIVIDUAL CLAIMS PARTICIPATION DURING 1953 OR 1955, DID HE VOLUNTEER FOR OR WAS HE OTHERWISE TASKED TO PERFORM DUTIES IN CLOSE PROXIMITY OF GZ.

C. REQUEST THE ABOVE INFO BE FORWARDED BY MSG DIRECTLY TO DIR, ARMED FORCES RADIOBIOLOGY RESEARCH INSTITUTE, BETHESDA, MD 20014, WITH INFO CY TO HQDA (DASG-HCH). (RCS EXEMPT PER PARA 7-2K, AR 335-15.)

D. THOSE INDIVIDUALS ELIGIBLE FOR TREATMENT IN ARMY MEDICAL FACILITIES WHO PRESENT THEMSELVES SHOULD BE CARED FOR AS APPROPRIATE. THOSE NOT ELIGIBLE FOR MEDICAL TREATMENT SHOULD BE REFERRED TO THE NEAREST VETERANS ADMINISTRATION TREATMENT FACILITY.

BT

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Dr. McINDOE. The ad hoc committee developed an executive summary which I will submit for the record. In essence, it agreed there is enough suggestive evidence to support a thorough inquiry into the questions raised by Dr. Caldwell and he should be given full support by the concerned Federal agencies. That the ad hoc committee be formally constituted as an interagency committee with DOD, Department of Energy, U.S. Public Health Service and the Veterans Administration being members. That review of all DOD personnel exposure records associated with the weapons test program be continued and the problems of internal dosimetry as determined by external monitoring also be reviewed. That a system be developed whereby dosimetry data be consolidated and easily retrievable without conflicting with the Privacy Act.

Close cooperation and coordination between Dr. Caldwell, DCSOPS, and AFRRI continued with his inquiries into the test shot Smoky. Dr. Caldwell visited AFRRI on August 18, 1977, to discuss the best way to proceed under the Privacy Act.

On August 24, 1977, a decision memorandum entitled, "Military Participation in Atmospheric Nuclear Weapons Tests and Possible Relationship with Medical Problems" was sent by the U.S. Army Surgeon General through the Chief of Staff, U.S. Army to the Assistant Secretary of Defense (Health Affairs), recommending a meeting, chaired by his office, to include representatives of the Surgeons General of the U.S. Army, U.S. Air Force, U.S. Navy, U.S. Public Health Service, the Medical Director of the Veterans Administration, the Director of the Defense Nuclear Agency, and the Energy Research and Development Administration.

On November 3, 1977, a preliminary meeting of the interagency group was held by ASD(HA) and they recommended the following course of action: Expansion of the epidemiologic effort to encompass all atmospheric tests and their relationship to the incidence of cancer in the participants. The studies be accomplished by the National Research Council and funded by the Department of Defense and Department of Energy. That one central administrative unit be established as the point of contact for coordination of all related activities. That a meeting of the agencies senior policy level officials be convened as soon as possible to organize this effort.

Representatives of DOD, DOE, HEW, NRC, and VA met on December 1, 1977. The summary of that meeting as reported by the Assistant Secretary of Defense for Health Affairs is submitted for the record [see p. 224].

As a result of this meeting the Defense Nuclear Agency was assigned the operational program responsibility for studies on possible long-term medical consequences of atmospheric nuclear testing and the AFRRI designated as manager of this effort. On December 23, 1977, the National Research Council was requested to develop a study protocol to investigate the possibility of an increased incidence of cancer in troop tests associated with the atmospheric nuclear weapons testing program.

Mr. ROGERS. Thank you very much. The papers you submitted will be received in the record without objection.

[Testimony resumes on p. 231.]

[Dr. McIndoe's papers follow:]

ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D. C. 20301

HEALTH AFFAIRS

DEC 14 1977

MEMORANDUM FOR - See attached list

SUBJECT: Summary Report; 1 December Meeting on Possible Long Term Medical Consequences of Atmospheric Nuclear Testing

A meeting on the above subject was convened on 1 December at the Pentagon to consider whether there is sufficient information available to determine if there is increased incidence of leukemia and other cancers in those military and civilian participants who participated in test shot "Smoky" in 1957 in comparison to a similar group in the general population.

Participants in the meeting included representatives of the OASD(HA), OASD(PA), the Military Departments, Department of Energy, Veterans Administration, the Public Health Service of the Department of Health, Education, and Welfare, and the National Research Council, National Academy of Sciences. Introductory remarks regarding the purpose and objectives of the meeting were made by Robert N. Smith, M.D., the Assistant Secretary of Defense for Health Affairs. The meeting was chaired by Major General Benjamin R. Baker, Deputy Assistant Secretary of Defense, Health Resources and Programs. A list of participants is attached (Tab A).

Colonel Vandy Miller, DASG, provided a briefing on the work conducted to date by the Ad Hoc Committee on Long Term Medical Effects, Operation Desert Rock which was formed by the Surgeon General of the Army in April 1977 to assess the problem, and on a meeting held on 3 November in the Office of the Assistant Secretary of Defense, Health Affairs to review that work and plan for the 1 December meeting (Tab B).

Briefings were also presented on the current status of investigations being conducted by:

1. Walter Reed Army Institue of Research (Col. Dobbs)(Tab C);
2. Center for Disease Control, USPHS (Dr. Caldwell)
3. Department of Energy (Dr. Weyzen)

Dr. Hobson (Veterans Administration) and Mr. Jablon and Dr. Weiss (National Research Council) discussed data acquisition problems and design requirements for a thorough study of the matter.

Mr. Guerny (Public Affairs) discussed information requirements to support public affairs activities.

It was the concensus of the participants that:

1. There is insufficient information currently available to make an objective determination of the incidence of leukemia or other cancers among participants in "Smoky" or other atmospheric tests conducted between 1946-1963.

2. Immediate steps should be taken to identify participants and initiate epidemiologic studies on several test shots from which data is relatively available.

3. Required epidemiologic studies should be conducted by an independent agency which has the experience and capability to provide an objective scientific assessment of the problem. The Medical Follow-up Agency of the National Research Council agreed to conduct the study and will develop preliminary research protocols. It is estimated that the study will take 2-3 years to complete.

4. Such studies should be sponsored jointly by the Department of Defense, Department of Energy, Veterans Administration, and the U.S. Public Health Service, DHEW. The DoD would assume lead agency responsibility.

5. Cost of the study is estimated at $100,000 to $150,000 for FY 1978. FY79 and FY80 cost estimates will be developed. Costs will be shared by participating agencies on the basis of their degree of involvement.

6. There is an immediate need for DoD to establish a project office to:

(a) coordinate all related activities within DoD, with other agencies involved, with Congress, the media and the public;

(b) develop and manage the contract with the National Research Council;

(c) provide assistance to the National Research Council in obtaining required data from the DoD and the Military Departments.

Possible loci discussed were:

(a) Army Medical Research and Development Command
(b) Armed Forces Radiobiology Research Institute
(c) Defense Research and Engineering

NOTE: Subsequent to the meeting, Defense Nuclear Agency (Mr. Haas) agreed to serve as the executive agent for this activity. The Army Medical Research and Development Command offered to amend their existing contract with NRC to facilitate early initiation of the study.

7. An ad hoc advisory committee consisting of representatives of all agencies currently involved and such other agencies (e.g., Department of Labor) as may be involved should be convened on a periodic basis by the Assistant Secretary of Defense, Health Affairs, to review the progress and findings of the study.

8. An action memorandum be prepared for the Secretary of Defense advising of the problem and obtaining approval for recommended actions.

Benjamin R. Baker
Major General, USAF, MC
Deputy Assistant Secretary of Defense
(Health Resources and Programs)

Attachments

LIST OF ADDRESSEES:

Captain Frank H. Austin
LCDR Lamarr G. Beuchler
Captain Joseph Bloom
Dr. Clyn Caldwell
Col Olin C. Dobbs
Mr. Gordon Facer
Captain Peter A. Flynn
Mr. Gene Guerny
Dr. Lawrence B. Hobson
Mr. Seymour Jablon
LTC William McGee
Col Darrell W. McIndoe
Col Vandy L. Miller
Mr. James E. Moynihan
Mr. Stuart Nelson
Col Taras Nowosiwsky
Mr. A. H. Simon
Maj Alan L. Skerker
Dr. Robert N. Smith
Captain M. I. Varon
Dr. Daniel Weiss
Dr. Walter Weyzen

EXECUTIVE SUMMARY

MILITARY PARTICIPATION IN ATMOSPHERIC NUCLEAR TESTS

1. Concern for the health status of personnel involved in nuclear weapons tests has been prompted by several recent events. Among these was the claim to the Veterans Administration by Mr. Paul Cooper in March 1977 that his exposure to radiation at a nuclear test on 31 Aug 1957 caused his current leukemia. His claim for disability benefits was initially denied, but later the VA awarded benefits while carefully avoiding drawing a connection between Mr. Cooper's exposure and his disease since there was no scientific evidence to support it. Mr. Cooper's physician notified Dr. Glyn G. Caldwell of the Center for Disease Control, USPHS, at Atlanta, Georgia of Mr. Cooper's case, expressing concern over the possible relationship between Mr. Cooper's leukemia and radiation received at the time of the nuclear test. Subsequently, Dr. Caldwell, through contact with a number of troops involved in the test, apparently identified several additional cases of cancer among the participants in the 31 Aug 1957 test.

2. In view of this, the Army Surgeon General requested a detailed review of troop participation in the atmospheric test program. A committee, referred herein as the Ad hoc Committee, was formed with representation from the Armed Forces Radiobiology Research Institute (AFRRI), Office of The Surgeon General of the Army, the Office of the Deputy Chief of Staff for Operations and Plans, Department of the Army, and the Office of the Chief, Public Affairs, Department of the Army to accomplish this review. The Director, AFRRI, served as Chairman at the request of The Surgeon General and with the approval of Headquarters, Defense Nuclear Agency.

3. This report describes the Committee's preliminary findings and recommends immediate action for The Surgeon General's consideration. The large number of tests involved in the atmospheric weapons testing program and the general widening of interest to tests other than the 1957 series make it apparent that the Committee's formal continuance is necessary and recommendations have accordingly been made for future inquiry under the auspices of the Committee.

4. The conclusions reached by the Ad hoc Committee are as follows:

a. Although adequate radiation safety procedures, to include monitoring programs, were established for each test series, enforcement of these procedures was not uniformly consistent and did not account for the hazard of internal emitters. Further, documentation of discrepancies in personnel monitoring and possible accidents or incidents involving potential overexposures or contamination is very difficult to find and may not exist. Resolution of this problem will not be easy and will require considerable assistance from [illegible] experts. Initial discussions with ERDA personnel have been fruitful, and Dr. Walter Weyzen, Manager, Human Health Studies Program, ERDA, is conducting an [illegible] survey in an attempt to answer the fundamental question of whether or not there were accidental radiation [illegible] at any of the test shots during the Desert Rock exercise.

Since there was no assay for ingested radionuclides, and some participants may have been exposed to contaminated dust, internal deposition of radioactive particles may have occurred. The magnitude and significance of internal exposure cannot be determined at this time and need further study as noted above.

b. External exposures, with some exceptions, were within the National Council for Radiation Protection and Measurement (NCRP) standards for occupational workers. It is unlikely that there could be an increased risk of cancer due to radiation on the basis of documented external exposures. The exposure records of personnel who were issued film badges during the period encompassing test shot Smoky have been collated into a listing by unit, with personnel then listed alphabetically. This will allow a listing by dose, which can then give a more precise picture of the overall dose frequency distribution. At this point, after inspection of the list, the Committee agrees that the dose/man received is very low, indicating an overall excellent control of external exposures. The fact that all participants in the nuclear weapons program were not issued film badges and the failure to maintain central control of radiation dosimetry records have resulted in a loss of dosimetry date. Corroborative information to establish the participation of some individuals will be difficult to obtain, and it unlikely that all individuals who participated will ever be obtained.

c. The Reynolds Electrical and Engineering Company, Inc. (REECO), a contractor for the Energy Research and Development Administration (Nevada Operations Office) has the most extensive and complete listing of personnel dosimetry data likely to be found. This list is automated and has been maintained and updated to include personnel involved in tests subsequent to 1958. Currently, about two million names are alphabetized. The Committee requested a listing of names from ERDA, specifically the military personnel (letter attached, Enclosure 1). Although ERDA personnel expressed a desire to assist the Committee, privacy act limitations have so far prevented them or the contractor, REECO, from providing the information. The listing does not differentiate between civilian and military; legally, REECO cannot provide a list with non-military personnel records included to the Department of Defense. This difficulty is no longer significant since Major Alan Skerker has completed his own detailed analysis of military records and compiled the list now being used for review of test shot Smoky. This DA list has been provided to ERDA for comparison with their records to confirm the data thereon.

d. Additional inquiries may be expected to include requests for exposure records, medical examinations and treatment.

e. There is a strong likelihood of further legal actions and compensation claims.

r. Dr. Glyn G. Caldwell's initial survey has suggested that there could well be an increased incidence of malignant disease in the population that participated in Smoky. A similar preliminary survey done by the Armed Forces Institute of Pathology corroborated these findings. Therefore, a more formal USPHS research study, with review of the protocol by DOD and ERDA, is in order. Dr. Caldwell has received communications from about 1000 persons, ten of whom are reported to either have presently or to have died (two cases) from leukemia. Dr. Caldwell's information is not specific or detailed enough to identify the types of leukemia involved - a critical point in any attempt to relate the leukemic incidence to radiation exposure. Six of the people involved definitely were at Smoky and two more are highly probable participants. The AFIP survey uncovered an additional sixteen cases of leukemia. A more detailed analysis of all cases of leukemia and other cases of cancer that may still be discovered is required. Therefore, following the meeting of epidemiology experts from the U.S. Army Medical R&D Command with Dr. Caldwell, it is strongly recommended that their review be coordinated with ERDA. ERDA is planning a separate epidemiologic review by Dr. Lushbaugh of Oak Ridge. In addition, Dr. Weyzen of ERDA suggested that an additional review by the National Academy of Sciences should be considered. The Academy has supervised the Atomic Bomb Casualty Commission Review of the Hiroshima and Nagasaki survivors and should be considered as a potential independent review body before a final protocol is approved.

5. In consideration of the Committee's findings, the following recommendations are made.

a. The Ad hoc Committee formed at the request of The Surgeon General of the Army should be formally constituted with representatives from each service, and the Defense Nuclear Agency to continue the investigation of the test program. A Memorandum of Understanding should be drawn up between the Department of Defense and other agencies; i.e., ERDA, USPHS, and the VA. Members of those agencies will be invited to become members of the Committee. The Canadian Ministry of Defense should be invited to send an observer from the Office of The Surgeon General of the Canadian Armed Forces.

b. There appears to be a need for an epidemiological study to identify, locate and obtain necessary follow-up medical data on participants in the Desert Rock exercise at test shot Smoky. It is recommended that a request be made to the US Public Health Service that the Center for Disease Control be the primary agency for conducting this study. The protocol should be reviewed by Department of Defense and ERDA. In addition, separate inquiries through medical information systems such as the one of AFIP will be done to provide background material for reviewing Dr. Caldwell's protocol.

c. Collection and review of all DOD personnel exposure data relevant to the weapons testing program through 1962 (participants, test plans, external/internal exposure records, deviation from test plans and safety procedures, etc.) be continued. The personnel exposure data collected to date covers the period in operation Desert Rock at the time of test shot Smoky. Analysis and review of this data here will constitute a model for review of other operations. The question of the uniqueness of Smoky and the possibility of special hazards associated with that test must be resolved first. To that end, the review now started by the office of Dr. [illegible] on the potential hazards of residual radiation at

Smoky is critical.

d. A review of methods and models for predicting internal deposition, retention, and estimated doses for exposed personnel with the goal of assessing the potential risk or hazards from internal deposition is required. After the preliminary review by ERDA as noted above, this issue can be addressed specifically. This will probably require a contract study.

e. A determination of the potential efficacy of external monitoring systems (whole body counting) in estimating potential internal depositions and the risks thereof should be done. This question will be referred to ERDA.

f. Determination of the approximate number of individuals who were exposed to radiation levels at various dose ranges. This is the next step in the review of the list collated by Major Alan Skerker. It is recommended that this be done under contract by a suitable activity if funds are available from ASD/HA. A work statement is in process of being developed by the Committee.

g. Such other problems and considerations that the Committee may in the course of its investigations uncover. Specifically the Committee should consider the current Enewetak cleanup operation and review the Radiological Safety Plan for that operation, particularly the plans for records keeping.

h. The services promulgate information and directives to appropriate medical facilities as required.

i. Promulgation of the following announcement by the Services: "A preliminary investigation of military participation in the atmospheric test program has been done by an Ad hoc Committee. Preliminary conclusions of the Committee is that external exposures were typically so low that radiation induced leukemia and other cancers are not likely. The Committee feels that there is no scientific basis to support a requirement for a general medical follow-up of nuclear test participants and no reasonable cause for public apprehension regarding the state of health of those who did participate. The Committee has been directed to continue its examination of the atmospheric test program to include participation by services other than the Army and to continue cooperating with Dr. Glyn Caldwell, U.S. Public Health Service, Center for Disease Control, Atlanta, Georgia, providing him necessary data regarding U.S. participants in the weapons testing program." This release has been promulgated by the U.S. Army and reviewed by The Surgeons General of the other Services. In view of recent developments, an updated press release and follow-up response are being studied.

j. That a central repository for weapons related dosimetry data be established. Since such a repository exists presently at the Nevada Operations Office of the Energy Research and Development Administration, an interagency agreement should be developed to provide authority for including information on military personnel in that central repository. A letter from the Assistant Secretary of Defense for Health Affairs to the Administrator, ERDA, suggesting this and outlining a meeting for discussion, is recommended.

LaWAYNE R. STROMBERG, M.D.
Surgeon, Defense Nuclear Agency
Chairman, Ad hoc Committee on
Long Term Medical Effects,
Operation Desert Rock

Mr. **Haas**. Mr. Chairman, with your permission, may I now introduce Major Skerker from the Department of the Army for his statement?

Mr. **Rogers**. Major Skerker?

STATEMENT OF MAJ. ALAN SKERKER

Major **Skerker**. Mr. Chairman, I wish to thank the committee for this opportunity to present information on the military participation in the Nevada atmospheric test to both you and the American public.

The statement I have prepared for the record is quite lengthy, and I would prefer simply to summarize with a few short remarks.

The first issue concerns how many tests did the military participate in, and how many people were involved. Inclusive of Desert Rock I through VIII, in that period there were 65 tests conducted at Nevada. Military personnel participated in 51 of those detonations. If one adds to that number the Ranger series in 1951, also conducted in Nevada, and the Hard Tack II series of 1958—both of which did not involve military participation—that brings the total number of atmospheric tests to 88, of which one was a misfire.

In looking at these tests, as I have done in my prepared statement, to try to identify those where I believe there may have been significant participation, I considered basically two aspects. First, the amount of people that may have been involved in the individual tests, and second, if there were any peculiar circumstances, either because of fallout, because of known overexposures, anything that might suggest that might be a logical place to go look in a followon effort. When I do that, prior to the Plumbbob series in 1957 I have identified in the text 13. In considering the Plumbbob series there are certainly five tests that ought to be looked at. But since the Plumbbob records are themselves in one grouping, we might just as well look at the entire population in 1957 then to try to distinguish between five, six, or seven tests.

So, in that respect my answer usually is that there are somewhere around 15 tests that we ought to be looking at.

In considering the total numbers of Desert Rock participants, I can identify from various operations reports a total number of 58,537 military as part of the Camp Desert Rock organization. To this I can also identify in a 1968 version of records from the Reynolds Electrical Engineering Co., that I happen to have in my possession, an additional 19,833 names of people who were predominantly AEC affiliated. That total comes, then, to 78,370 Desert Rock Armed Forces special weapons project and AEC personnel.

Unfortunately those numbers cannot be accurate. At the bottom of page 1 of my prepared text I indicate that we know that the Tennessee Air National Guard flew reconnaissance missions at Smoky. These people are not going to be found in the Army file. To my knowledge they are not found in the AEC file. So, the question is, where is their dosimetry information?

Mr. **Rogers**. May I just ask this at that point—I am sorry to interrupt you—I understood you kept rather close records on exposures. Have they just been destroyed?

Major **Skerker**. No, sir. We are talking about groups of people being atttached or assigned to different organizations, one of which is the 6th U.S. Army at Camp Desert Rock headquarters. Another group of people assigned to the Armed Forces special weapons project, and the Atomic Energy Commission out at Camp Mercury.

Mr. ROGERS. Yes.

Major SKERKER. And then possibly a third group who may have their exposure records in the Air National Guard system, perhaps, or some other system not associated directly with the Army or the AEC.

Mr. ROGERS. Did the Air National Guard people, for instance, keep their own records?

Major SKERKER. I have indications that they do have some dosimetry information.

Mr. ROGERS. No; what I am saying is, does the Army or the Air Force of the Department of Defense have a record on the people that participated, or did you just give the records back to everybody who participated?

Major SKERKER. No, sir because, if I may, sir, these are people who flew from the coast, flew toward Nevada, hovered 20,000 feet in the air, ran a photo recon mission on Smoky, landed some place and flew back to the coast. So, in other words, they were never really associated with either Camp Mercury, the AEC headquarters, or Camp Desert Rock from the standpoint of administration.

Mr. ROGERS. I understand that, but who monitored their exposure to radiation?

Major SKERKER. I do not know, sir.

Mr. ROGERS. What was the purpose of having them up there?

Major SKERKER. I do not really know that, either.

Mr. ROGERS. Who ran the operation? I thought the Department of Defense ran it. Did AEC run it?

Mr. HAAS. The entire Plumbbob series, Mr. Chairman, was under the central operation of the Atomic Energy Commission. Shot Smoky was a shot in that series for an AEC and joint Department of Defense purpose. The Desert Rock operation was operated outside of this organization by the Department of the Army in Camp Desert Rock.

The Air National Guard operation such as has been described by Major Skerker was apparently organized by yet another organization outside of the AEC and outside of the Department of Defense.

Mr. ROGERS. What organization?

Mr. HAAS. Apparently the Air National Guard, sir.

Mr. ROGERS. The Air National Guard just all of a sudden put in their own people?

Major SKERKER. No, sir. All I am saying, at this point in time, sir, I do not know who organized that mission and what its prupose was. All I know is that it was not an Army mission.

Mr. ROGERS. Well, do you have any records to show who put this together?

Major SKERKER. I do not have any dosimetry records for those individuals.

Mr. ROGERS. No; what I am saying is, who made up the whole program?

Major SKERKER. I have not found any documentation so that I can intelligently say to you today who organized the program, what their purpose was. The way in which we found out about it was through letters that Dr. Caldwell had received. He passed that information on to us, and we passed it on to DOE to ask them if they had any knowledge of overflights. That is something I simply cannot answer.

Mr. ROGERS. In other words, the Air National Guard was put into the picture, but you do not know by whom.

Major SKERKER. That is correct, sir.

Mr. ROGERS. They were ordered from Tennessee, and no one knows who gave the order to bring them from Tennessee.

Major SKERKER. I do not know who gave the order.

Mr. ROGERS. Do you have any liaison with the Air National Guard?

Major SKERKER. No, sir. The Department of Energy is the one that supplied me that information.

Mr. ROGERS. So, the Department of Defense had no dealings with the Air National Guard in regard to the flight

Major SKERKER. I am not aware of any, sir.

Mr. ROGERS. What would be the normal procedure. Were any other tests run where the Air National Guard was brought in?

Major SKERKER. It is very likely that there are other, similar kinds of involvement. For example, I have found in press releases that I was reading the other day that there were 307 aircraft who flew over in 1953, of which 49 were bombers. So, I would assume that those would be centered in the Air Force.

Mr. ROGERS. Who put out the press release?

Major SKERKER. That was from the Nevada operations office, sir.

Mr. ROGERS. So, they had some knowledge of it in Nevada? I thought you said they were not knowledgeable.

Major SKERKER. I am saying there is knowledge there going back a quarter of a century. The question is to find who today has that kind of knowledge. There are a number of people, of course, today who were then on Plumbbob and the earlier series, and very often the case is that they were involved at a much lower level capacity than they are in today and in some cases may not really have been cognizant of all the things that were going on. I mean, that is the impression that I get. Of course myself, in 1951, I was 8 years old.

Mr. ROGERS. Well, I was not trying to hold you personally responsible, Major, for decisions made then, I doubt if I could even hold you personally responsible for decisions made now. However, I might add that I would think that you must have some records. I presume, from what you tell us, you have the exposure records of people who were exposed?

Major SKERKER. Yes, sir.

Mr. ROGERS. So, we have those.

Major SKERKER. Yes, sir.

Mr. ROGERS. Now, whoever was doing the overall study, I presume, kept all the records together. Would that be a normal expectation?

Major SKERKER. No, at that time there was no central depository, sir. The concept of a central depository for dosimetry records is relatively recent and I believe dates to around 1964.

Mr. CARTER. Mr. Chairman, I believe there should be an explanation of that. Many dosimetry records were kept at the Bluegrass

Signal Corps Depot at Lexington, Ky. I do not know since when, but the Smoky dosimetry records were there.

Major SKERKER. Sir, only the Army Desert Rock records were at the Lexington Bluegrass Signal Depot. None of the AEC records were at Lexington Bluegrass, nor anyone not associated with the Army.

Mr. CARTER. I was referring to the Army, not AEC.

Mr. ROGERS. So, it is the Army records there.

Major SKERKER. Yes, sir, I have the Army records.

Mr. ROGERS. Now, here is what I want to know. Who was to make the judgment on exposure, whether it was dangerous, what the records were; and who was responsible for tying it together? Was it the Army, was it the Department of Defense, or was it nobody?

Major SKERKER. I can answer it now, sir, or answer it in the course of what I plan to present.

Mr. ROGERS. Sure.

Major SKERKER. Well, let me go through it now.

In terms of the radiation safety limits, these tended to parallel whatever national standards were in existence at the time, with interpretations in the same way we interpret those radiation standards today. For example, I might point out in 1958 the International Council on Radiation Protection in going to the yearly dose from the weekly dose, one of the reasons for that was to permit a certain amount of flexibility in the radiation industry. In other words, one could then integrate and differentiate in any way they basically pleased, as long as they met the yearly dose. So, if one looks at the exposure limits throughout the test series—as I have indicated in the body of my statement, sir—they generally are in agreement with that concept. Perhaps one could question the wisdom of doing things like that; and I think that is perhaps one of the objectives that your subcommittee is looking into.

Mr. ROGERS. I do not know that you have responded to the question, I think you missed the point. I am saying, who was responsible for maintaining all of the records, for drawing conclusions as to whether there was exposure from analyzing the results, and tying it all together. Was everyone just kind of doing it on their own?

Major SKERKER. The responsibility shifted. We start out in 1951, the Atomic Energy Commission——

Mr. ROGERS. Well, suppose we just keep it to Smoky, use that as an example; and then we will go into a broad explanation after that. Why not just tell us, who was responsible for Smoky, where these planes flew through the cloud from Tennessee, the Army was involved, AEC. Now, who was responsible?

Major SKERKER. In Smoky the entire radiological safety for ground troops rested with the 6th U.S. Army. These records were processed by a team from the Lexington Army Signal Depot. Those are the records that we have today. They have in fact been kept in Lexington on microfilm. Also, in the early 1960's sometime were sent to the AEC to be included in the RIGO file.

Mr. ROGERS. I see. So, you have no idea on any planes that flew there.

Major SKERKER. No, sir, I do not know who had the responsibility for the other services—not for the other services associated with Desert Rock, but for any other involvement outside of Camp Desert Rock, other than the AEC had at Camp Mercury for its employees.

Mr. ROGERS. What about your helicopters?

Major SKERKER. The helicopters were part of Camp Desert Rock, sir.

Mr. ROGERS. So, it was all within the one command.

Major SKERKER. Yes, sir.

Mr. ROGERS. But you had no high-flying planes.

Major SKERKER. That is correct, sir, we did not have any bombers.

Mr. ROGERS. And you made no requests that that be monitored.

Major SKERKER. That we would make any request—I do not quite understand your question, sir.

Mr. ROGERS. After the atomic bomb had been dropped, nuclear weapons, when you said the planes from Tennessee flew through it, the cloud—for the monitoring, I presume—you had made no requests. Do you know where the request came from?

Major SKERKER. No, sir, I do not. It was not actually a Desert Rock operation. What I am trying to indicate to the committee in addressing specifically the question of how many people were involved, I can tell you what the records say about the Army participation and those people under the wing of Camp Desert Rock. I can tell you what I know about the AEC, but I cannot tell you anything about anyone else who may have been under someone else's wing and participated in atmospheric nuclear testing.

Mr. ROGERS. So, you are saying you had nothing to do with it, no judgment, no coordination at all. Is that my understanding?

Major SKERKER. The coordination, presumably, shoud have been with the AEC.

Mr. ROGERS. Yes, we will get into that with the AEC. But it was not the responsibility of the Army to coordinate anything other than your own troops there.

Major SKERKER. With the exception of ground forces there, sir, the Army did not have any functional responsibility at Desert Rock.

Mr. CARTER. Mr. Chairman?

Mr. ROGERS. Yes, Dr. Carter.

Mr. CARTER. Under whose command was the Tennessee Air National Guard?

Major SKERKER. I do not know that, sir.

Mr. CARTER. You do not know that. Have you made an effort to find out?

Major SKERKER. No; I have not, sir.

Mr. CARTER. And the Air Guard unit flew at 20,000 feet. Is that correct?

Major SKERKER. They hovered at 20,000 feet in a flight pattern about 30 to 35 miles to the southest of ground zero, and apparently some time shortly after detonation flew a photo recon mission.

Mr. CARTER. How many men were involved?

Major SKERKER. I believe Dr. Caldwell has knowledge of 10.

Mr. CARTER. Dr. Caldwell you say. You do not know how many men of the Tennessee Air National Guard were there?

Major SKERKER. No, sir, I do not.

Mr. CARTER. Do you know how many men have developed leukemia?

Major SKERKER. There is one case in those 10, I believe, sir.

Mr. CARTER. There is one case.

Major SKERKER. One potential case.

Mr. ROGERS. Well, we do not expect you to have to report on something you knew nothing about, or the Army knew nothing about, or had nothing to do with. So, we will confine it to those items you are knowledgeable about.

Why don't you go ahead and finish your statement? I apologize for interrupting.

Major SKERKER. Another problem with determining the number of people, I would like you to refer to the table between pages 17 and 18 in my statement. In this table is listed the number of participants for each of the Plumbbob shots from various services and the Canadian Government.

Dr. Caldwell had requested that I look specifically at project 50.8, that was a radar tracking type of experiment, and try and determine exactly how many people were involved in that. The total in the tables is 7,711. You will also note that there are essentially three apparent groups of people, one of 557, one of 105, and one of 50. I have determined all of the people who were involved in that project for the entire Plumbbob series, and the total comes out to 749.

There are basically two temptations, sir. One is to say that the project started at 557, drew down to 105, and then to 50. The other would be to say that perhaps there are really three distinct groups. But the number of 749 is a little bit bigger than that, and it suggests that people were going in and out.

The reason I bring this up is that here we have a total 20,103, and that is our only knowledge other than to physically go ahead and count people on records that we have, and in so doing we are going to find that this is an overstatement. That is suggested by the footnote, incidentally, it says, "Same personnel accumulative total." That really does not help you to determine how it was accumulated.

So, I have basically taken the position, then, when asked how many people were involved, until we can identify, for example, all of Plumbbob or all of some other test, is to go with a basic number of 80,000, which I feel represents a reasonable order of magnitude to kind of scope the problem for the Plumbbob series.

Concerning radiation safety, sir, I think what I have tried to do objectively in my statement is to indicate some pluses and some minuses as to troop exposures, radiation safety limits, the accidental occurrences of fallout where it had not been anticipated, and so forth.

When you look at all this and consider the fact that, yes, there were film badge programs, no matter that in some cases they were inadequate, they did not cover every individual, they definitely utilized radiation dosimetry instruments that, at that time, were the best available. The ANPDR 27, which is the main one used by the Army, has gone through, essentially, five changes, five redesigns.

We do see that not only were radiation safety limits established, but we also see that there were operational limits established. In other words, if I have a counter that could only measure 500 mrem per hour it is of little consequence to tell me that I cannot accumulate 3 rem total dosage. But if you do tell me, you cannot go into a radiation field beyond 500 mrem per hour, you set a rational limit.

In that sense there is, I think, reasonable evidence that there was a radiation safety program.

On the other side of the fence, if you look at the known cases of overexposure, accidental occurrences in terms of fallout going in the wrong direction, you have to conclude that in some cases these radiation safety programs were not entirely effective. That is basically what I am saying.

Mr. ROGERS. How many cases of overexposure have been found?

Major SKERKER. On Plumbbob, prior to the Smoky Shot, there are 10 in the Army records. On the Smoky list there are two clear and one pretty close, so, I count that as three.

Mr. ROGERS. When was this determined?

Major SKERKER. When was the overexposure information determined?

Mr. ROGERS. Yes.

Major SKERKER. The knowledge of the overexposures around August, because I came upon them in the list, there was essentially an affidavit that lists 10 people and says they were overexposed. But there is no backup documentation in the file that really explains the circumstances, simply that there were 10 that were exposed to between 5 and 7 rem. I came across that in doing a detailed search of the files in August.

The other three became apparent as I was doing the list and certainly, we know they exist.

Mr. ROGERS. Has any effort been made to track down these people?

Major SKERKER. No, sir. At this point I have not made an effort to contact any individual. What I have tried to do is to establish the best I can who was there, in the hope that if you give this to whomever does the followup study and has the resources to do the legwork, that is a place to start.

Mr. ROGERS. How many people do you have working full time on this project?

Major SKERKER. On the list, myself.

Mr. ROGERS. One person?

Major SKERKER. Yes, sir, on the microfilm records. I also get a tremendous amount of assistance in trying to track down health records through public affairs, who makes the contacts out in St. Louis.

Mr. ROGERS. How many people do they have devoted full time?

Major SKERKER. I have one main contact in there.

Mr. ROGERS. One man?

Major SKERKER. Yes, sir.

Mr. ROGERS. So, actually there are two of you trying to run down these people, or get the records.

Major SKERKER. Right, sir.

Mr. ROGERS. Because you are not making any attempts to contact them.

Major SKERKER. That is correct, sir. If we have to go out and contact people, we would certainly need a much larger force to do that kind of legwork.

Mr. ROGERS. Have you done any similar work for tests in other years?

Major SKERKER. Yes, sir.

Mr. ROGERS. To what extent?

Major SKERKER. It really kind of varies. I would like to say something about the volunteer program which will indicate a small segment.

Mr. ROGERS. We would like for the record——

Major SKERKER. In my statement——

Mr. ROGERS. Well, let me finish first. I will tell you what we want, first; it may be that. We want a complete list of all of the exercises, explosions, and the troops involved; a complete rundown of those records as to the numbers, exposures, and so forth. And what has happened, if there were ever notifications by the Army of this. If you have made any attempt at all to notify anybody—maybe not run them down. Also, we want to know the number of people involved, such as you have just given us, if that varies at all. I think that would be helpful for the record.

Major SKERKER. Alright, sir.

Once of the things I would like to discuss, since it has been the central focus of today's hearings, is essentially the Smoky paradox. I would like first to give you a very brief bit of arithmetic that kind of explains what the problem is.

Shot Smoky was detonated at 0530. It is reported that personnel reached the 500 mrem per hour line at 0915, and that the operation was terminated at 0945. Let us look at the total span of events, from 0530 to 0945, that is 4¼ hours. If I was standing right here being exposed to 500 mrem per hour for 4¼ hours, I would have received 2¼ rem, and people showed up with exposures greater than that.

In effect, what I am saying is, if we look at the available——

Mr. CARTER. Sir, I would like to know the number of hours you said, if you please.

Major SKERKER. Sir?

Mr. CARTER. The number of hours of exposure.

Major SKERKER. Four-and-a-quarter hours from the time of the detonation to the time the exercise terminated. That is assuming that a man was instantly in the high radiation field. I use that simply to illustrate that there is uncertainly concerning how the people got the exposures. When one looks at the film badge, we believe the film badge records are reasonably accurate. In other words, if a man shows up with 2.9 rem, that reasonably that represents 2.9 rem of external exposure.

Mr. CARTER. External exposure?

Major SKERKER. Right, sir, not internal. There is no way of determining the internal dose. For example, I believe Dr. Sperling gave some testimony yesterday in which he made some estimates of the internal dose.

Mr. CARTER. If I may, Mr. Chairman?

Mr. **ROGERS**. Yes.

Mr. **CARTER**. What about alpha rays, how are they recorded?

Major **SKERKER**. No way of determine that, sir.

Mr. **ROGERS**. No way of determining those.

Major **SKERKER**. No, sir.

Mr. **CARTER**. And they were the ones that were in the dust, supposedly, nearest to the site, nearest to ground zero?

Major **SKERKER**. Well, you had a mixture of alpha, beta, and gamma.

Mr. **CARTER**. All of them.

Major **SKERKER**. The proposition is basically that if you go into a mixed radiation field from a fission device, that the predominant radiation is gamma. You can measure that, and if you can stay within what you believe to be a reasonable amount——

Mr. **CARTER**. But you really do not know.

Major **SKERKER**. You really do not know; that is correct.

Mr. **CARTER**. You do not know if alpha was more or less because there was no way of measuring it, was there?

Major **SKERKER**. No way of measuring it, but there are some physical bounds.

Mr. **CARTER**. There are what?

Major **SKERKER**. There are some physical bounds which I cannot present to you today. In other words, what we are saying, you know, is it possible to have an alpha dose many orders of magnitude times the gamma dose? I would say there is obviously some reasonable physical bounds beyond which you just cannot say what would happen.

Mr. **CARTER**. You referred to Dr. Sperling. I believe he stated that the probable alpha dose was 16 rem?

Major **SKERKER**. I recall 13.2 in one case.

Mr. **CARTER**. 13.2? I will not argue over 2.8 rem. But much higher than your standard of five-tenths of a rem, or 500 mrem.

Major **SKERKER**. That was a localized dose to the bone marrow, and of course under the assumption of a good deal of resuspension.

Mr. **CARTER**. Thank you, Mr. Chairman.

Mr. **ROGERS**. You may proceed.

Major **SKERKER**. The final thing I would like to talk about is the volunteer program, and if I may just read my last page.

During five tests, Nancy, Badger, Simon, Apple II, and John, which was on July 19, 1957, trained nuclear effects officers and one DA civilian GS-12, volunteered to observe these detonations at closer range than any other troops at these tests. Men were given information about the expected yield of the weapon and data concerning the terrain and meteorology. Using the technical effects manual prepared at the Command and General Staff School each officer derived for himself what he believed to be a safe distance from where he could observe the detonation.

After each of the volunteers had completed his computations he met with members of his group to arrive at a group consensus as to how far away they were willing to be. The group decision was presented to the Camp Desert Rock commanding general for approval. A trench at the approved distance was then dug.

On the John shot, which is a 2 kt device at approximately 20,000 feet, six observers were placed at ground zero. The Army Air

Defense Command commander accepted responsibility for their safety.

On both the Simon and Badger tests exposures were as high as 16.3 rem that have been reported. To date—and there is a change to this since this was written—24 of the 43 volunteers have been identified by name.

The trenches were dug at the following distances:

Nancy, 2,500 yards; Badger, 2,000 yards; Simon, 2,000 yards; Apple II, 2,600 yards, and John of course, there was no trench.

Well, gentlemen, this concludes my statement. I shall be pleased to answer any questions you may have and provide any data you may need for the record.

[Testimony resumes on p. 266.]

[Major Skerker's prepared statement follows:]

STATEMENT of

MAJOR ALAN L. SKERKER

NUCLEAR DIVISION

STRATEGY, PLANS, AND POLICY DIRECTORATE

OFFICE, DEPUTY CHIEF OF STAFF FOR OPERATIONS AND PLANS

DEPARTMENT OF THE ARMY

Mr. Chairman, I wish to thank this sub-committee for the opportunity to present you and the American public, information concerning the participation of military forces in atmospheric nuclear test programs conducted during the 1950's at the Nevada Test Site.

I am Alan L. Skerker, a Major in the Corps of Engineers, serving in the Nuclear Division; Strategy, Plans and Policy Directorate of the Office of the Deputy Chief of Staff for Operations and Plans, Department of the Army.

The principle of employing military forces in conjunction with atmospheric nuclear tests was established jointly by the Services to provide realistic training, enable the testing of doctrinal concepts, and maximize the dissemination of nuclear effects knowledge among members of the Armed Forces. In 1955, Major General Leland S. Stranathan, USAF (Commanding General, Field Command, Armed Forces Special Weapons Project) wrote of the AEC and DOD cooperation:

"There are three primary objectives in military participation. First, the assurance of compatibility of AEC developments with DOD weapons systems. Second, the acquisition of effects information for military use, both offensive and defensive. Third, the reduction of total costs to the Government by preventing duplication of effort."

"As a secondary objective, test detonations are used to train troops to check our weapons delivery systems and to try to discover and correct weaknesses in our techniques, tactics, and equipment. "Desert Rock" operations and participation by some tactical aircraft are examples of programs for this purpose. "

Broad statements of purpose, though perhaps eloquent, are superficial for these can not address the detailed objectives related to each test. I will have some further comments on individual tests throughout my testimony. I have selected this quotation for a more significant reason. The last sentence suggests that there were military participants who may not have been under the direct wing of either the Sixth U.S. Army's Camp Desert Rock Headquarters or the Atomic Energy Commission. We now know that in 1957, the Tennessee Air National Guard flew reconnaissance missions at SMOKY. These men are unaccounted for in either the film dosimetry records of the Army or the AEC (DOE), and there are likely to be others who participated in a similar manner in prior years.

My discussion of many tests will be brief. I will try to focus upon the information most pertinent to identifying that test as a candidate for detailed study. On other tests I will be able to elaborate in more detail.

The most important issue is the status of the health of individuals who participated in atmospheric testing. If an increased risk of leukemia, other cancers or related maladies can be clearly demonstrated then we will have a basis for attempting to establish the causal mechanism. To this end it is important to document the status of dosimetry records and other documents that identify participants. I do not believe it possible to set up a follow-on study that is totally independent of Service assistance in identifying test participants because in many instances the audit trail through historical documents is obtuse. If this premise is accepted then the establishment of a central supervisory body is essential to acheive inter-Service and inter-Agency responsiveness.

Another area of importance that I will discuss concerns the radiological safety programs that were established. I anticipate considerable discussion in these hearings concerning the validity of film badge records and instrument surveys. I caution against concluding that if an increased risk of leukemia is apparent then it must be the result of unrecorded or improperly sensed high radiation environments. This could lead to years of continued ignorance and a missed opportunity to learn something about leukemia that is not known today. I will however address known overexposures and highlight tests and circumstances where the likelihood of additional overexposures exists.

A final area I will discuss is the participation of small groups of officers who volunteered to witness nuclear detonations at distances somewhat closer to ground zero than other participants.

Desert Rock I

The first use of Army ground forces in conjunction with a nuclear detonation occurred on November 1, 1951. A 21 kt device was detonated in the air at 1417 ft over ground zero. This shot was designated the DOG event of the AEC test series Buster-Jangle.

5266 personnel assigned or attached to Camp Desert Rock witnessed the DOG event from as close as seven miles. A Battalion Combat team of 883 individuals moved in fifteen columns to 900 yards from ground zero. The cumulative exposure limit was established at 3r and the intensity beyond which no movement would be allowed was set at 1r/hr.

The AEC retained complete control of radiation safety, and provided 15 monitors who moved at the head of each troop column carrying the AN/PDR-T1B ion-chamber survey meter with a range of 0 - 50r/hr. An additional 45 monitors from the Battalion Combat Team accompanied the columns carrying the AN/PDR-27 Geiger-Muller counter with a range of 0 - 500mr/hr. Other instrumentation was carried various personnel from the BCT and III Corps staff.

The limit of 1r is consistent with permissible laboratory and industrial exposures as summarized in the "Handbook of Atomic Weapons for Medical Officers" prepared by the Armed Forces Medical Policy Council for the Departments of the Army, Navy, and Air Force and published under the auspices of the Armed Forces Special Weapons Project in June 1951. Though intended for occupational workers exposed throughout their lifetime, standard (3) concerning external radiation states:

> "Individuals working with external radiation
> for short period not to exceed 2 years.
> 1.25 r/month - single exposure allowable if
> no further exposure that month."

Film badges of Dupont type #553, having a range of .1-250r were issued to each observer, service participant, and member of the maneuvering Battalion Combat Team. Approximately 3% of these badges were not turned in, damaged, opened, or lost. The highest exposure of Desert Rock personnel was reported to be 320 mr. A REECO list of film badge records from 1951 contains many higher exposures, none of which appear to be military participants. The records of those persons clearly identifiable as military are consistent with the averages of several tens of millirem reported for the different groups of Desert Rock participants. There is an implicit assumption in this statement which needs to be clarified.

The battalion combat team personnel received two badges. One of these they placed along with their equipment in a prepared defensive position dug prior to the detonation in the vicinity of ground zero. The other film badge was worn on the day of the exercise. In the REECO file there are military participants with two badge records, one a low reading of several tens of millirem and the other a record about five to ten times higher. These men are not identified by unit and the reported numbers do not exactly match those of the battalion combat team though there is a close correspondence. Thus the validity of the statement that the records and reported exposures are consistent depends upon the validity of the assumption that the higher of the two badge readings was the one left in place on the defensive position when the device was detonated.

The objectives of Desert Rock I were to:
1. Indoctrinate troops in the tactical employment of atomic weapons and in essential physical protection measures.
2. Test the effect of the explosion on many types of ground force equipment and deployment with varying degrees of protection.

As part of the first objective, the Human Resources Research Office (HumRRO) of George Washington University, operating under contract with the Army, conducted a psychological study of troop reactions to an atomic explosion.

The HumRRO report provides this narrative description of instructions issued just prior to the detonation with the men in position 7 miles from ground zero. At H-5 minutes, the report states that the men were told:

"Turn and sit down. Face South....Leave room so you can turn after the nuclear explosion in sitting position until the blast wave passes, which will be approximately 30 seconds after the explosion. You will turn approximately 2 to 3 seconds after the burst on my command. The noise will be a crack or rumble as we told you in the orientation...", then at H plus 2 seconds they were ordered: "Turn in position, stay seated. The blast will be here in 15 seconds." About forty seconds later the report states that the men were ordered to stand up and look at the cloud.

During the hour following the burst, the participating troops waited for the AEC to complete monitoring radiation intensities and give the clearance for the operation to proceed.

The HumRRO report offers this observation concerning the the Desert Rock I maneuver:

"Under the restrictions set by the Atomic Energy Commission, it was difficult to make the maneuver realistic. The usual performance requirements, such as the use of weapons, the opposition to a simulated "enemy", and mock combat, were absent. The troops moved across the terrain at each emplacement in single files, a formation likely to render them highly vulnerable to enemy fire, if there had been any. Thus, the men's estimate of the vulnerability of the "enemy" depended chiefly on their observation of damage to equipment."

"By all accounts, this phase of the operation appears to have been disappointing to the troops. There were no buildings near ground zero, and the sparse vegetation of the desert provides a less spectacular target to the A-bomb than structures do. Moreover, damage at the emplacements was not comparable to the damage rendered to a target more likely to be bombed under actual conditions of combat. Indeed, in General John E. Hull's later estimation, the troops of Exercise Desert Rock I "were there purely as observers and there was no tactical problem involved." "

I presume this observation was held by others because in the years of subsequent atmospheric nuclear testing there was a trend towards increased participation of military forces in tactical maneuvers. Along with this trend there occurred a shift in radiation safety responsibilities from the AEC to the Service troop unit commanders.

Since the Desert Rock I exercise is the most highly controlled of these tests it is important to include these participants in a subsequent follow-on study. If an increased incidence of leukemia were to be found among this group it would suggest the likelihood of something other than a high radiation exposure as the cause.

Desert Rock II and III

Desert Rock II and Desert Rock III appear to be less significant from the standpoint of troop participation. The AEC retained control of radiation safety, although the limiting total exposure, approved by the AEC, was increased to 3 R. The operational limit of 1 r/hr maximum intensity remained in effect.

Desert Rock II occurred in conjunction with the SUGAR event of 19 November 1951. A 1.2 kt device was detonated at 4 ft above the surface. There was no troop maneuver. Participants were drawn from Camp Desert Rock support units who prepared instrumented equipment and emplacements. An observer program is mentioned but there is no record of who or how many individuals may have been involved. At this time all that can be identified are 25 service and support units and the names of 25 individuals on the Desert Rock staff. Since the REECO list from 1951 contains 6,679 records it is possible that some Desert Rock II personnel are included.

Desert Rock III was a cratering shot that occurred on 29 Nov 1951. A 1.2kt device was buried 17 ft below the surface. Sixty personnel were reported to have participated in an observer program. We have a list that identifies 62 individuals. Observers witnessed the detonation from 5.9 miles and at H+3 minutes returned to Camp Desert Rock. Forty-five hours after the detonation the observer group returned to view the display areas.

Desert Rock IV

Desert Rock IV coincided with the AEC Tumbler/Snapper series of detonations. Troop participation occurred in conjunction with four shots, with ground forces from the Army and Marine Corps. During this exercise the Army was given increasing responsibility for radiation safety. The maximum permissable exposure was established at 3 r. Individual film badges are reported to have been issued to each participant; to have been processed by the Test Command, Armed Forces Special Weapons Project, and records of individual dosimetry forwarded to the participants home station for inclusion in his medical records. A central repository for this dosimetry data probably does not exist. The REECO dosimetry data for 1952 includes 2770 names while the total Service participation in this exercise is reported to be 7224.

The first of the Desert Rock IV troop maneuvers occurred in conjunction with the Charlie event on 22 April 1952. Troops observed a 31 kt device detonated at 3447 ft above ground zero, from entrenchments 7000 yards from the ground zero. Other observers who did not participate in the troop maneuver viewed the detonation from 10 miles away, believed in the vicinity of News Knob.

At 0920 participants were ordered into foxholes and trenches. The Exercise Director ordered participants to kneel, cover their faces with their hands, and lean against the forward wall of the trenches and the foxholes. At H+3 seconds the command was given to raise and look at the fireball. Approximately 15 seconds later the blast wave arrived. At 0955, twenty five minutes after the detonation Army CBR monitors moved towards the direction of ground zero survey the area across which the troops were to move. At 1026 these monitors informed the Exercise Director that it was safe for personnel to advance. At 1029 the Exercise Director ordered the Airborne Infantry Jump Company to execute its mission and at 1030 the ground forces moved forward by truck to view the static display area while at 1115 the Airborne maneuver north of ground zero was completed. It is believed that both ground and airborne units converged towards ground zero approaching as close as 175 yards, equivalent to 1162 yards from the detonation center.

We do not know what part of the 7224 participants participated in this maneuver.

On 1 May 1952, the Marine Corps participated in a ground maneuver in conjunction with the DOG shot, a 19kt detonation from a height of 1040 feet. An Army control group drawn from the Camp Desert Rock Cadre provided radiation safety control for the Marine movement. Monitors from the Marine Corps assisted.

On both the Charlie and Dog shots monitoring of the route of advance was done by the participating troops under AEC supervision. Beginning with the third shot of the Desert Rock IV series a further transition occurred and the Army was permitted to monitor the route of advance without AEC supervision.

The FOX event, an 11 kt shot from a 300 foot tower involved Army troops from the 701st Armored Infantry Battalion, 1st Armored Division and approximately 500 individual observers from all major Continental Armies. This exercise occurred on 25 May 1952 and consisted of an administrative movement forward towards ground zero from entrenchments at 7000 yards.

HumRRO administered a psychologically oriented test to the troops of the Armored Division. The stated purpose for this phase of the exercise was to make a "psychological evaluation of the reactions of participant troops to various aspects of their total maneuver experience."

Seven areas were investigated by HumRRO:
"(1) Information about Atomic Effects From the viewpoint of the military commander, troops participating in an atomic maneuver must possess, at minimum, enough information for safety and for confident execution of their duties."

"(2) Fear Reactions; If troops are afraid, their general efficiency may be affected in any of several ways. The range of possible reactions in atomic warfare might extend from highly undesirable disruption of behavior, as in panic, to such desirable behavior as caution, forcefullness, and the like."

"(3) Confidence: If men lack confidence in their own fighting ability, in their leaders, and in the atomic scientists who prescribe rules for the use of weapons, they can hardly be expected to perform at maximum efficiency in action. It seemed reasonable to suppose that familiarizing men with atomic weapons and demonstrating that such weapons could be used with safety would increase troops' confidence."

"(4) Adjustment to the Army: The effects of the maneuver on the troops' general satisfaction with Army life and on their feelings about their unit were considered important indicators of changes in morale."

"(5) Attitude toward the Maneuver: It was thought that changes in troops' estimates of how well the maneuver was conducted and their opinions of its utility as a training device would indicate changes in morale, and receptivity to training during the exercise."

"(6) Willingness to Volunteer: Quite aside from the question of whether the man who enters dangerous situations voluntarily will always perform better than the man who does not volunteer, willingness to volunteer is generally conceded to be a desirable behavior from a military standpoint."

"(7) Post-Maneuver Dissemination of Information and Attitudes: The Army recognizes that atomic maneuvers can have a potentially great influence on non-participants through the dissemination of facts and attitudes after the participant troops and observers have returned home from such maneuvers."

The conclusions reached by HumRRO are both positive and negative. The following examples are cited to indicate this balance:

"The proportion of men who indicated a willingness to volunteer to view the detonation from 4 miles and 3 miles increased after the detonation and this level was maintained three weeks later."

"There was no evidence of the troops performance being disrupted by fear."

Conclusions concerning information gained by troops were mixed. "Most consistent gains in information from the various briefings were in those areas having to do with personal injury rather than those involving less personally relevant nuclear effects."

Little change was effected in either attitudes or information gained by non-participants. The report restates the conclusion reached in the 1951 HumRRO report: "word of mouth communication between participant and non-participant troops was no more effective in disseminating correct facts than it was in influencing attitudes."

The last event of the Desert Rock IV series was the GEORGE shot on 1 June 1952. This was a 15 kt shot from a 300 foot tower. There were reported 450 observers in addition to participating troops who advanced from trenches at 7000 yards towards ground zero immediately following the arrival of the blast wave. Radiation safety on this shot was completely delegated to the Army by the AEC. A forward movement limit of 500 mr/hr was established. This lowered limit was required because the range of the AN/PDR 27 was 0 - 500mr/hr. At about 500 yards from ground zero this maximum permissable intensity was reached and the advancing troops are reported to have shifted laterally to avoid the high intensity regions and proceeded to 175 yards from ground zero from another direction.

The guidelines for radiation exposure in 1952 are believed to have been 0.3 R/wk for continuous exposure. In the technical manual TM 11-5543, "Radiac Set AN/PDR-27" the following is found under the heading Radiological Safety Warning: "All personnel working in high intensity levels of radioactivity must exercise caution to prevent bodily damage. While the radiation from radioactive substances usually can not be seen or felt, prolonged or intensive exposure may result in serious damage. Three tenths of a roentgen per week (.3R/wk) is considered to be the maximum amount of such radiation which can be absorbed continuously each week as a peace time tolerance dose." This is from an August 1952 edition of this manual.

Radiation exposure guidelines in the civilian scientific community have historically been based upon avoiding long term continuous exposures that would reach high dose accumulations at which the risk of deleterious effects was considered demonstrable. The change in the ICRP guidelines from weekly to yearly exposure limits in 1958 for example, was clearly meant "to permit flexibility" in determining short term exposure rates. A total dose of 3 R per test series for a participant, in the absence of other exposures during the year would on that basis be consistent with .3R/wk continuous permissable exposure throughout the year.

The radiological safety regulations are reported to have been established by Headquarters Test Command, AFSWP, Rad-Safe Group, in a letter dated 24 March 1952, subject "Radiological Safety Regulations."

Procedures taken to meet the AFSWP requirements included:

a. Issuance of film badges to all personnel moving into the forward area. Processed film badges were turned into AFSWP where the recorded dosage was forwarded to the Camp Desert Rock Surgeon and then forwarded to the individual's home station.

b. Camp Desert Rock furnished monitors to survey the entire routes of approach to and through contaminated areas, for observer groups on shot day, and individuals or work parties on other days.

c. Providing for decontamination of personnel and vehicles.

Since it was recommended at the conclusion of the series that a Chemical Service Company be assigned to Camp Desert

Rock for all future exercises in order to provide adequately trained monitor and decontamination personnel; and, that a Radiological Defense Engineer, MOS 7330, be assigned in all future exercises to give technical advice to the exercise director and his staff, it must be presumed that these functions were preformed by Camp Desert Rock cadre or AFSWP personnel.

Desert Rock V

The spring of 1953 marked the third occasion on which maneuvers were conducted by the Services in conjunction with atmospheric testing.

Troops participating in the Desert Rock V exercises, in contrast to previous exercises, came as individuals or small groups from various posts throughout the U.S. Few integral units participated. The assembly of a complete list of participants will for this reason be extraordinarily difficult, and we may not be able to assemble a complete record at all. Personnel, upon arrival at Desert Rock, were assigned to Provisional Combat Teams.

These Provisional Battalion Combat Teams were given various types of orientation prior to participating in the maneuver.

The Special Instructor Group, Camp Desert Rock, provided a four-hour block of instruction that included a security briefing, lectures on the effects of atomic weapons and the protective measures against those effects, and an orientation concerning the events on shot day.

After this instruction the men were taken by truck to the forward area for a rehersal of the maneuver. They were shown how to enter the trenches, oriented on the terrain, and acquainted with the various commands they would be expected to fdlow on the shot day. From the trench area they moved to the equipment display area to observe items set out prior to being damaged by the nuclear detonation.

The first of the Desert Rock V exercises occurred on 17 March 1953. A 16 kt device designated the ANNIE event was exploded on a 300 foot tower. There were 1741 participants. Two Provisional Battalion Combat Teams observed the detonation from trenches at 3500 yards. Fifteen minutes afterwards the men moved forward through the dust to an objective 1200 yards from ground zero. From there they and the observers viewed the equipment display area, approaching to 700 yards from ground zero. It was reported that there were some control problems keeping the monitors from advancing too far forward of the troop body.

On 24 March 1953 the Nancy event, a 24 kt device was detonated from a 300 foot tower. Participation in this event was 2848 military and 16 civilians. On 22 March 1953 the observer group had entered the ANNIE equipment display area. The levels of residual activity have not yet been identified. For the NANCY shot, observer trenches were located at 4000 yards. A wind shift blew the radioactive cloud over the trenches where the dose due to cloud passage is reported to be 18 mr. The Provisional Battalion Combat Team launched their attack three minutes after the explosion and moved to between 500 and 700 yards ground zero. There was heavy fallout in the maneuver area and an intensity of 14r/hr at some unknown point was reported. The CBR monitors proceeded into the contaminated area without giving any indication of their readings to their commanders. Upon the direction of the Rad-Safe Officer units were withdrawn but the unit commanders experienced difficulty in withdrawing their forces.

Film badges were not issued to each man. The allocation of badges was one per platoon and one per observer bus load. This was done because the film dosimetry section could not keep up with the workload.

The NANCY shot should receive a priority effort in the followup program. The identification of participants will be particularly difficult since they came from units in the 2d, 3rd, 5th, and 6th Armies.

The BADGER event of 18 April 1953 was a 23 kt device detonated from a 300 foot tower. This was predominately a Marine Corps exercise. Participants reported are 2723 military and 10 civilians. The 2d Marine Corps Provisional Atomic Energy Brigade was formed from two battalions, the 1st Bn/ 8th Marine Division and the 2d Bn/ 3rd Marine Division. These units were entrenched at 4000 yards from ground zero at the time of the detonation. A wind shift blew fallout over the eastern portions of the trenches. Shortly after the maneuver began the 1st Battalion was taken out of action since 6R was recorded on their pocket dosimeters. As with the NANCY event, this shot has considerable potential for over-exposures. Since most of the participants came from organized units it may be much simpler to construct a participant list for this exercise than others in the Desert Rock V series.

The SIMON shot of 43kt from a 300 foot tower occurred on 25 April 1953. 3102 military and 24 civilians were entrenched at 4000 yards. The observer group, on 23 April, viewed the static display area from the BADGER event of 18 April. Two Provisional Battalion Combat Teams were organized from personnel of the 2d, 4th, 5th, and 6th Armies.

Fallout affected the trench areas but the total dose is reported to have been 25 mr and less. The eastern Battalion Combat Team encountered higher intensities than did the western BCT. The advance is believed to have been halted at the 2.5 R/hr intensity.

The ENCORE event occurred on 8 May 1953. A 27 kt device was airburst at 2425 feet above ground zero. 3049 military and 21 civilians were entrenched at 9800 yards from ground zero. Two Provisional Battalion Combat Teams were again deployed in the maneuver with two platoons of 60 individuals being airlifted to an objective 4500 yards from the trenches. The forces attacked through ground zero at 1 hour after the detonation reporting an intensity of 260 mr/hr, and after reaching a second objective moved to view an equipment display area.

The 280 mm Atomic Cannon was operationally test fired on 25 May 1953. The 15 kt projectile detonated at 524 feet in the air. This event was named the GRABLE shot. This test firing was observed by 3228 military and 31 civilians from entrenchments at 5000 yds from ground zero. Eleven minutes after the detonation, two battalion combat teams attacked towards objectives at 6500 and 8000 yards from ground zero and then continued towards the display area. One BCT could not observe the displays due to a dust storm which severely limited visibility.

Three other tests occurred as part of the UPSHOT-KNOTHOLE series. On one there was no military participation. The two others were witnessed by 63 and 135 observers. Total participation in Desert Rock V was 17,696 from all the Services: Army - 13,364, Navy & Marine Corps - 2,921, Air Force - 1,273, Civilians from each military department - 139. The number of participants for the GRABLE shot probably do not include 792 VIP observers, and the figure for the ANNIE event includes 30 civilians. If these two latter adjustments are made, then the individual test figures are short by 39 military and 7 civilians from the quoted totals. These may be personnel assigned to Camp Desert Rock who did not participate.

"The mission of Desert Rock V was to provide indoctrination training in tactical operations featuring tactical employment of atomic weapons; to provide training in essential physical protective measures; to provide indoctrination training for participating troops and troop observers on the effects of an atomic explosion on animals and equipment; to demonstrate, within limits or restrictions established by AEC and AFSWP, influence or modifying effects of atomic weapons on field fortifications and defensive structures; to measure the ability of trained staff officers to estimate target damage; and to observe psychological effects on individuals resulting from atomic explosions."

"The U.S. Army was given complete responsibility for radiological safety of participating military personnel. Permission was given for troops to maneuver toward and around ground zero without restriction as long as there was no interference with AEC instrumentation lines or AFSWP test displays."

Concerning the radiological safety program the following was reported:

"The Directive for Exercise Desert Rock V, issued by OCAFF,* made the Exercise Director solely responsible for providing radiological safety for all participants in the exercise."

"The Directive provided the Exercise Director with criteria to be used in exposing participants to atomic weapons effects. These criteria provided for a maximum permissable dosage of six (6) roentgens for the exercise."

"Based upon the above criteria the Rad-Safe Officer prepared an SOP for Radiological Safety covering all operations in the forward area. These procedures prescribed the use of radiac instruments and film badges, monitoring requirements and decontamination regulations."

"Prior to each shot the Radiological Safety Section conducted a school for monitors selected by the participating BCT's. During the maneuver following each shot these monitors checked for nuclear radiation in the area used by their respective units. In addition, the Rad-Safe officer and his monitors surveyed the entire maneuver area, reported intensity levels to the exercise Director, and exercised overall radiological safety control."

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* Office of Chief of Army Field Forces

Desert Rock VI

Desert Rock VI coincided with Operation Teapot during which there were 15 detonations between 18 February and 15 May 1955. On three of these shots there was no military participation from Camp Desert Rock reported. On two shots there were large military maneuvers, one by the Marine Corps and the other by the Army. On the remaining ten shots participation varied between 45 and 1047 individuals limited almost entirely to the observer indoctrination program. A total of 8185 military from each of the Services took part in Desert Rock VI.

The Marine Corps maneuver was held in conjunction with the BEE event, 22 March 1955, employing an 8 kt device detonated from a 500 foot tower. The total participation in this test was 2269. Test participants observed this shot from trenches at 35oo yards.

The APPLE II event, 5 May 1955 was a 29 kt device detonated from a 500 foot tower. 1919 participants, predominately from the Army took part in a combined arms maneuver and a test of regimental communications. There was a small group of participants from the Air Force (25).

Film badges for Desert Rock VI were issued on the basis of one per permenant party observer, one per VIP, one per squad of official observers, one per tank crew, and one per individual not in a group. No central repository of dosimetry records has been found, but there is evidence that exposure records were forwarded to the individuals home station for inclusion in his medical records.

Overexposures reported are: 97 persons between 3R and 6R; 15 persons between 6R and 20R; and 2 persons greater than 20R. The largest exposure is not known, nor are the individuals who received the above exposures, identified.

I would like to digress a moment on how I have viewed my role and the priorities of tasks as I perceive them. Early in my conversations with Dr. Caldwell I became convinced that the problem,of determining if health risks were associated with participation in atmospheric nuclear tests, could not be resolved by a study of SMOKY. A follow-on effort of some magnitude would be needed to convincingly prove or refute the allegations for a number of tests. But a follow-on effort must have a basis; it must have a reason, and it must have points of departure. SMOKY has provided sufficient reason. We know that six people associated with the ground forces at that test have leukemia, and that this number is uncomfortably high. It may be a statistical fluke but that must be proved. SMOKY, howeves is only one point of departure and we need others. The question then is what constitutes a point of departure ? My answer is people; we can determine the health status of an individual only if we know whom to look for. I thus have set certain priorities.

First: Establish lists of participants.
Second: Establish lists of units.
Third: Establish relevant operational factors.

In summary, the following has been accomplished.

Lists of participants.

1. List of probable SMOKY participants in hard copy.
2. List of Canadian participants in Operation Plumbbob provided to the Government of Canada.
3. Microfilm dosimetry records for Desert Rock VII/VIII are immediately available for the follow-on study
4. Microfilm records of morning reports for over 30 units for 1955 are immediately available for the follow-on study.
5. Twenty-four of the 43 volunteer officers have been identified.
6. Between 600 and 700 names from orders and fragmented information from 1953 are being compiled in a card file.
7. The names of 342 civilian observers at APPLE II with city addresses appear in the report on Operation Cue. Other reports identify a few names each.
8. 87 observers and staff from Desert Rock II and III have been identified. Similar small numbers of key staff are available for other DR tests.

Lists of units.
At least some units are known from each of the Desert Rock series from lists in operations reports. Other units and headquarters have been identified from orders and technical reports. Some additional information has been found in the historical files of Army station lists, and some additional information relevant to the early Pacific tests has been located in unit histories.

Relevant Operational Factors. These are I trust summarized in this testimony.

Continuing my discussion of Operation Teapot and Desert Rock VI, I wish to point out that three project reports reveal deficiencies in radiac equipment.

Project 2.3b, Gamma Radiation [illegible] Above Fallout Contaminated Ground: Radiation measurements were made above a fallout field using a sodium-iodide scintillation counter mounted on a van. The pulse height distribution from this detector was analyzed by a twenty channel spectrum analyzer inside the van. Subsequently this data was numerically integrated by two different techniques giving 494 and 362 mr/hr - by comparison, "a hand held 27C survey meter read near 300 mr/hr"

"A radiacmeter is a compromise instrument in which scientific accuracy is sacrificed for practicality. It is calibrated by a source (usually Co^{60}) placed at some definite position with respect to the instrument. Such calibration achieves reproducible results. If the source gamma energy were changed, a different calibration would generally result. It is assumed that this energy and directional dependence is of such a nature that the readings are not misleading in the usual case."

Project 6.1.1a, Evaluation of Military Radiac Equipment: "Satisfactory tactical dosimeters and rate meters are now available for measuring gamma radiation: the IM-93, and the IM-108(XE-2)/PD. However, beta and neutron radiations can also have very important biological effects. The importance of these effects from nuclear detonations is becoming more and more recognized."

"The beta radiation problem is mainly a problem of rate meters, since there is little significant flash beta radiation from nuclear detonations, and since the problem is mainly one of determining whether a contaminated area is safe to remain in or enter. No available rate meter meets military specifications and measures beta radiation satisfactorily. Casualties could easily result from beta burns received in a contaminated area indicated safe by gamma instruments of the AN/PDR-39 or IM-108 type."

It should be noted that the range of the IM-108 is 1 - 500r/hr and the AN/PDR-39 is essentially the AN/PDR-T1B both high range instruments.

Of significance as an indicator of the desire to provide military personnel with the best possible equipment, the following is quoted from the above report:

"The IM-108(XE-1,XE-2)/PD was operated in a residual-radiation field by members of CBR teams of the 50th Chemical Platoon (SVC) and the Third Marine Corps Provisional Atomic Exercise Brigade in a side-by-side comparison with the new standard instrument, AN/PDR-39. All but one of the 35 men using the instruments read the same radiation intensity on both instruments in all surveys made with the instrument."

The report makes some detailed comparisons between the IM-93 pocket dosimeter and the NBS (Evans Signal Lab) film pack when exposed to fallout fields and the Co^{60} calibration source. Both exhibited similar non-linearities in the response to the fallout field. Above 80 kev both devices gave a similar response, peaking between 100 and 150 kev and essentially flat at higher energies. The IM-93 exhibited a sharp cut-off at 50 kev while the NBS film pack cut-off at 80 kev and exhibited a response down by 30-50% at 50 kev.

Project 6.1.2, Accuracy of Military Radiacs: This report deals exclusively with high range instruments of the AN/PDR-18 series, the T1B, and a Civil Defense instrument CDV 710.

"Wide variations were found in the indications of instruments of the same type in identical field situations. The project data indicate that errors as high as 50% may occur with carefully handled and calibrated instruments. On the basis of this work, it is concluded that radiac instruments should not be used to make close estimates of percentage radiation casualties. Radiac errors should be given consideration in the establishment of combat directives and radiation tolerances."

"All instrument types were found to read low, relative to the standards, owing to deficiencies in the present calibration procedures."

Desert Rock VII and VIII

Desert Rock VII and VIII encompasses 24 events of Operation PLUMBBOB, the 1957 AEC test series. A list of these shots is provided in the accompanying table.

I would like to focus my remarks on the participation of the 1/12th Infantry at SMOKY and the participation of the Provisional Company 82d Airborne at FRANKLIN PRIME, SMOKY, and GALILEO.

1/12th:
The 1st Battle Group, 12th Infantry is reported to have witnessed the DOPPLER event (11kt balloon shot @ 1500 ft) from trenches at 3500 yards from ground zero on 23 August 1957, and then to have formed the nucleus of Task Force Warrior for the maneuver at SMOKY. If the Task Force attacked out of its landing zone towards its planned objective, and if the only available fallout contour maps are correct, then the only way to explain the film badge readings is to assume that units encountered hot spots that were not recorded. If they attacked instead towards the hill behind ground zero then most of the film badge records make sense.

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ANNEX-E
ACTUAL PARTICIPATION FROM ALL SOURCES
OBSERVERS-TROOPS – PROJECTS
EXERCISE DESERT ROCK VII & VIII

	OBSERVERS							TROOP UNITS							PROJECTS *								TOTAL PARTICIPANTS EACH SHOT
	ARMY	NAVY	CIV.	AIR FORCE	MARINE	CANADIAN	TOTAL	CDR	ARMY	NAVY	AIR FORCE	MARINE	CANADIAN	TOTAL	50.3	50.4	50.5	50.6	50.7	50.8	53.4	PROJECT TOTAL	
BOLTZMAN		74		63			137	176						176							34	34	347
FRANKLIN							0							0	25				3			28	28
LASSEN								205						205	25	5	4		3			37	242
WILSON	41	-	7	26	15		89	164						164	25	5	4	2	3	557	24	620	873
PRISCILLA	540	5	10	17	38	107	717	105				311		416	25	5	4	2	3	557	0	596	1729
DIABLO (misfire)	91	6	8	45		25	175	170				1703		1873	25	5	4	2	3	557	36	632	2680
HOOD	308	1	1	5		2	317	299				1517		1816	25	5	4	2	2	557	36	631	2764
DIABLO II	566	3	8	9	28	7	621	81						81	25	5	2	2	2	557	46	639	1341
JOHN	30	1	2	38	11		82	17						17	25	5	2	1	2	557	0	592	691
KEPLER	708		11	25	5	108	857	88						88	25	5	2	1	2	557	30	622	1567
OWENS	77		3	1		24	105	21						21	25	5	2	1	2	557	0	592	718
STOKES	95		3				98	99	499				40	638	25	5	1	0	3	557	35	626	1362
SHASTA								9	11					20	25	5	1	0	3	557		591	611
DOPPLER	9			2			11	66	492					558	25				1	557	56	639	1208
# FRANKLIN PRIME								49	121				3	173	25				1	557	48	631	804
SMOKY	384	3	3	15	9	43	457	51	1104				40	1195	25				1	557		583	2235
GALILEO								18	177					195	23					105		128	323
WHEELER								12						12	23					105		128	140
LA PLACE								7						7	23					105		128	135
FIZEAU								10						10	28					105		133	143
NEWTON															28					50		78	78
RAINIER															28							28	28
WHITNEY															28							28	28
CHARLESTON															28							28	28
MORGAN																							
SUB-TOTALS	2649	93	56	246	106	318	[illegible]	1647	2404	0	0	3531	83	7666	584	55	30	13	34	7711	345	8772	20,103

OBSERVED BY SMOKY OBSERVERS

* SAME PERSONNEL ACCUMULATIVE TOTAL

ANNEX E - ACTUAL PARTICIPATION FROM ALL SOURCES
OBSERVERS - TROOPS - PROJECTS

The purpose for the SMOKY test as reported in the "Report of Test, Infantry Troop Test, Exercise Desert Rock VII&VIII" was:

"a. To determine and establish the troop support, material and equipment required to construct a defensive position adequate for protection from the effects of an atomic explosion."

"b. To determine the validity of tactical doctrine, organization, planning data and helicopter requirements for the movement of a reinforced company task force, by helicopter, to seize an objective in conjunction with the use of an atomic weapon.

"c. To determine the suitability of techniques and procedures to effect resupply, by helicopter, of a reinforced company task force."

To this a most significant reason for conducting this test was to demonstrate to the public the ability of the Army to operate on the nuclear battlefield.

Major General Binns, Chief of Staff, HQ Sixth US Army wrote the following in a letter to the Commanding General, US Continental Army Command, 22 Jan 1958:

" The Troop Test conducted at Exercise DESERT ROCK VII and VIII forcibly pointed out the following conditions which necessitate a solution prior to the next Exercise DESERT ROCK:
a. It is not possible to conduct a troop test and obtain conclusive results when such a test is tailored in the form of a demonstration for observers and the press.
b. Due to limited state of training of participating troops and the many restrictions necessarily imposed by the Atomic Energy Commission, unrealistic and artificial requirements which preclude valid conclusions were imposed on the tactical maneuver at the Nevada Test Site."

The Infantry Troop Test was conducted in three phases:

Phase I - Defense Against an Atomic Explosion. The battle group constructed a defensive position on the hillside behind the location where the SMOKY device would later be detonated. "The participating troops were scheduled to return to the defensive position after the completion of the exercise to inspect the damage; however, this was not possible due to radioactive contamination in the area."

Phase II - Aerial Movement of a Task-Force. A reinforced company task force, initially disposed in a defensive area, was assembled and moved by helicopters a distance of eight miles to seize an objective, in conjunction with the detonation of the SMOKY device of 44kt from a 700 foot tower. Of primary interest during this phase were the techniques employed in the aerial movement of the task force, the tactical organization of the task force for movement, and the adequacy of techniques for employing pathfinders.

Phase III - Aerial Resupply of a Task Force. After the completion of phase II the Task Force was resupplied exclusively by helicopters until the termination of the exercise. Of primary interest during this phase were the techniques and procedures involved in the resupply of the task force by helicopter.

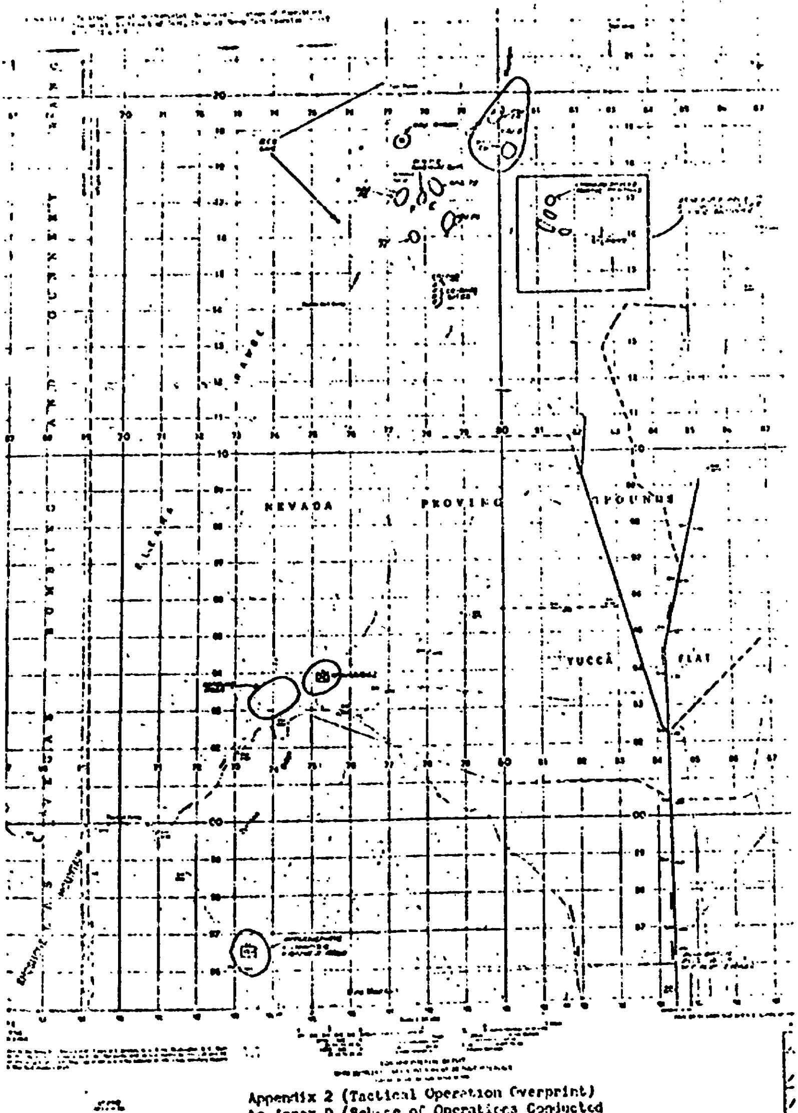
The SMOKY Operation

On 2345, 30 August word was received that due to wind conditions unfavorable to the original plan, the TASK FORCE was to prepare to execute an alternate plan that placed the attack on the western side of the test area instead of on the eastern side.

At 0530 31 August, SMOKY was detonated. The closest troops observed in the open from 8 miles of ground zero.

At 0545 the pathfinder group departed the helicopter assembly area and proceeded to the landing zone. After making a preliminary aerial survey, the heicopters landed in the landing zone at 0617. The pathfinders carried one pocket dosimeter for each man, each man wore a film badge, and the team had five AN/PDR39/T1B Ion Chamber survey meters. At 0629 the pathfinders reported that the area was safe for the Task Force to begin its airlift. Gnd Rad-Safe personnel are reported to have accompanied the pathfinder team to assist in the radiation survey.

The first lift of four serials carrying three rifle platoons and the weapons platoon of Company C arrived in the landing zone beginning at 0715. The 2d Platoon with an attached 81mm mortar squad seized objective P4. The 3rd Platoon seized obj P3. The 1st Platoon seized objectives P1 and P2.



Appendix 2 (Tactical Operation Overprint) to Annex D (Scheme of Operations Conducted to Report of Test, Infantry Troop Test, Exercise DESERT ROCK VII and VIII

D-2-1

Beginning at 0731 the remainder of the Task Force began departing the loading area. The Canadian Army Platoon after deploying from the landing zone seized objective QUEEN. Elements of the reconnaissance platoon and the engineer squad were landed at pre-designated points on the reconnaissance and security line to the west.

At 0825 and 0835 the first two patrols were dispatched by helicopter. At 0830 the 2d and 3rd platoons were ordered to execute the attack to seize objectives 2A and 2B. The 4th platoon occupied the vacated positions.

At 0915 the attack was halted prior to seizure of objective 2 due to having reached the rad-safe limit. No action transpired until 0945 when the exercise was terminated

The rad-safe limit was 500mr/hr. We do not know where the attacking forces were halted. The only available radiation contour maps show the 500 mr/hr line skirting the edge of the defensive positions that had been prepared in phase I approximately 3/4 of a mile to 1½ miles from Objective 2. The following comment is recorded:

At 0915 "Aircraft for patrols #2, #4, and #5 landed at landing site ECHO between 0915 and 0930 hours; patrols could not be located. These aircraft were diverted to transport VIP's at the termination of the exercise."

No further mention is to be found concerning when these patrols were found or where they had gone. If these patrols were of about squad size and if they had patrolled along the eastern edge of the attack they conceivably could have been closer to ground zero then they were supposed to be, and account for the high exposures.

Provisional Company 82d ABN:

Task Force Big Bang of the 82d Airborne Division arrived at Camp Desert Rock the evening of 12 August. The Task Force consisted of 170 personnel, 100 equipped with the M-1 rifle, the remainder carrying carbines. The Commanding General, CONARC is reported by the HumRRO to have requested that the CG 82d Abn Division cooperate with HumRRO in accomplishing their testing mission.

On 14 August the Provisional Co. was briefed on the purpose and content of the HumRRO testing.

"The primary objective of HumRRO's participation in the Desert Rook exercises, as stated in June 1957, was to orient selected research personnel from the Training Methods Division, and the Armor, Leadership, and Infantry Human Research Units, CONARC, to problems associated with training troops for participation in atomic warfare. A secondary objective (which subsequently became the raison d'etre for the team) was to gather pilot data relevant to research planning in the area of Army training. "

It was decided by HumRRO to concentrate upon two aspects of troop reaction to atomic weapon usage:

"(1) response upon first exposure to the initial effects of an atomic detonation, and (2) reactions to the contamination of terrain by nuclear radiation."

The HumRRO team employed in addition to a variety of questionairres, two significant tests; a rifle disassembly and reassembly test, and an infiltration course.

The HumRRO report goes into considerable detail concerning shot delays and their impact upon test administration, changes in plans and changes to these.

The infiltration course ended at 3200 yards from ground zero. It consisted of:

a. A 15 yard crawl going under a barrier.at the start and end.
b. A 15 yard sprint to a foxhole, counting an estimated lo secs before getting up and sprinting 15 yards to another wire barrier and a final sprint to a grenade toss.
c. A grenade throw range (simulated grenades) of 12 yards to the target.

On 27 August it was announced that SMOKY was postponed. It was decided that the HumRRO team, the assistant monitors, and the carbine equipped troops would witness FRANKLIN PRIME a 4.7 kt ballon shot at 750 ft. height of burst.

To ensure that the 82d accomplished their own mission of witnessing a detonation, when it was learned that SMOKY would be fired it was decided that the entire Task Force from the 82d would witness the detonation. From the HumRRO account "...all observers for SMOKY would be positioned approximately 12 miles from ground zero." If this distance is accurate then it would have placed the Provisional Company between News Knob and the SMOKY official observer area an unknown location.

I have been presuming this estimate of distance to be in error, but based upon conversations with Representative Carter's staff of one man who says he viewed SMOKY from the vicinity of News Knob, and the observation in the HumRRO report that, "...the troops were deployed over a very extensive area..." it is likely that this company could have been stationed at various positions along the sloping terrain generally to the northeast from News Knob and Yucca Pass.

The following account is given by HumRRO concerning the events at the Galileo shot:

"On 1 September, as a result of conferences with the Desert Rock Staff, the HumRRO testing mission was again attached to GALILEO, scheduled for detonation on 2 September. Because of time limitations, no construction of courses would be attempted; consequently, the mine field task was dropped from the test battery. It was planned that troops would be stationed in the open (no trenches) approximately 4500 yards from the tower. Since it was not feasible to have Post Engineers clear an area for the rifle stripping test, the troops would assume the administrative formations utilized for the test prior to the detonation of the weapon. Each squad would locate a small clearing for the testing. It was planned that the rifle test would be administered at two points in time: (a) one minute after the shock wave hit the troops the test would be administered to six squads of 12 men each, and (b) five minutes later the remaining four understrength squads would begin the test. The squads were not assigned to the testing times at random. This change in administration of the rifle test was necessitated by the departure from Desert Rock of two more members of the HumRRO team, leaving only three civilian monitors, supplemented by NCO's from the Task Force."

"After the rifle testing was completed, it was planned that the troops would be transported to the infiltration course located in the SMOKY area for testing. Entry of troops into the SMOKY area would be contingent upon approval of the Camp Desert Rock Radiological Safety Officer, following his survey of the area on 2 September."

"At 0130 hours, 2 September, the task force departed Camp Desert Rock, arriving in the Galileo area approximately 0245. The troops remained in open trucks until approximately 0500 when they moved on foot to the area designated for observation and testing purposes. The early morning air seemed unusually cold in comparison with previous nights, and several groups of men built brush fires while waiting for the detonation...."

"Two of the NCO monitors were not present, having failed to return from a weekend pass. Only 80 of the original sample of 99 paratroopers were present for the same reason."

"The loss of two NCO's and the reduction in number of troops present necessitated a last minute adjustment of the plans for the rifle test. The plan to test approximately 24 men five minutes after the shock wave hit the troops was abandoned, and these men were integrated into the six squads to be tested at H plus 1 minute, four of the squads being increased to 13 men and two squads to 14 men."

"At 0540 hours, GALILEO was fired, and the rifle disassembly reassembly test was begun shortly after the initial shock wave hit the troops. The dust level was quite high, as expected, with resulting impairment of visibility. After the test was completed, a number of the paratroopers commented on the difficulty of accomplishing the test due to the visibility problem and the atmospheric temperature."

" Upon the completion of the rifle test, Radiological Safety monitors and one member of the HumRRO team proceeded to the crawling course in the SMOKY area to monitor the radiation level in the area. The task force messed on assault rations while awaiting orders. At 0710, the Task force was informed that the crawling course could be used for a period of only one hour. The troops were briefed by the Radiological Safety Officer on the radiation conditions in the SMOKY area and on the precautions to be taken while in the area. The Task Force then proceeded in convoy from the WHEELER (??) area to the crawling course. The testing on the crawling course began at 0805 and was completed at 0855, all troops withdrawing on foot from the course to the trench area where they mounted on the waiting trucks."

Plumbbob Overexposures

Throughout Plumbbob ten cases of overexposure are identified for the period preceeding the participation of the 1/12. An additional three high exposures, two clear overexposures have been identified, all from the 232d Signal Company. The magnitude of these last three exposures suggests that they may have been in the path of the fallout field, perhaps in the vicinity of Banded Mountain during the SMOKY event.

The AEC reports a total of 44 overexposures in addition to the Desert Rock totals.

Officer Volunteer Program

During five tests, NANCY, BADGER, SIMON, APPLEII, and JOHN (19 JUL 57) trained nuclear effects officers and one DA civilian GS-12, volunteered to observe these detonations at closer range than any other troops at these events.

These men were given information about the expected yield of the weapon and data concerning the terrain and meteorology. Using the technical effects manual prepared at the Command and General Staff School each officer derived for himself what he believed to be a safe distance from where he could observe the detonation.

After each of the volunteers had completed his computations he met with the members of his group to arrive at a group consensus as to how far away they were willing to be. The group decision was presented to the Camp Desert Rock Commanding General for approval. A trench at the approved distance was then dug.

On the JOHN shot (2 kt at 20,000 ft) six observers were placed at ground zero. The Army Air Defense Command, commander accepted responsibility for their safety.

On both the SIMON and BADGER tests exposures as high as 16.3 R have been reported. To date 24 of 43 volunteers have been identified by name.

The trenches were dug at the following distances:
NANCY 2500 yards
BADGER 2000 yards
SIMON 2000 yards
APPLEII 2600 yards
JOHN - no trench

Gentlemen, this concludes my statement. I shall be pleased to answer any questions you may have and provide data for the record as you may require.

Mr. ROGERS. Thank you. On the volunteer program, have any of those volunteers been identified as having leukemia or other cancers?

Major SKERKER. No, sir. Eight of them apparently were alive and well as of 1971. I have phone numbers dating from December 1951 and addresses.

Mr. ROGERS. Have death records been viewed as to those who are no longer here?

Major SKERKER. No, sir, this just came up very recently.

Mr. ROGERS. You do not know of those who have died, what they died from.

Major SKERKER. No. I do know that one of the eight in the high exposure group is living. I could not contact him yesterday. At least he has a current phone number. The man at the John shot who was reported in the newspaper a couple months back is alive and well.

Mr. ROGERS. I thought you said before you were not contacting people, you were simply looking at records.

Major SKERKER. Well, I have certainly talked to a lot of people. In other words, for example, typically when I get an inquiry the first thing I try and do, since the information is often a bit hard to decipher in a letter, I will try and call the man up.

Mr. ROGERS. Well, I just thought your testimony was inconsistent with what you said before. You said here you had made a determination to find out what happened to these, and that eight were still living.

Major SKERKER. Well, I felt this particularly important because this represents what we know is a high-range, or a high-dose exposure group. I thought it would be of interest.

Mr. ROGERS. I understand, but your testimony before to the committee was that you were not doing that; and now you tell us you are in certain groups.

Major SKERKER. Well, basically, if I am taking the initiative to look at a particular group——

Mr. ROGERS. But you are having to do that by yourself, basically, with one man from public relations helping you?

Major SKERKER. Yes, sir.

Mr. ROGERS. That does not seem to indicate very high priority for the Department of Defense to help assemble these records.

Let me ask you, too, if you are notifying these people, evidently are trying to get them, why are you not making the same effort for those who have been identified in other shots, who were overexposed? Is there any reason to draw the line? Is it because these were volunteers and the others were not?

Major SKERKER. No, sir, it is simply because I have a better lead on these people.

Mr. ROGERS. Why?

Major SKERKER. I had an address and a phone number at least dating back to 1971.

Mr. ROGERS. I thought you also had the last known address of these others?

Major SKERKER. No; I do not.

Mr. ROGERS. You do not. Do you know where to get them?

Major SKERKER. Yes, sir. On some of these people I have more complete information than on others. In some cases I just have names.

Mr. ROGERS. What are your responsibilities in the Defense Radiological Agency, what are your responsibilities in that Agency?

Major SKERKER. As a member of the Nuclear Division, sir, I basically handle a variety of actions, both with the Joint Staff and unilaterally in the Army, dealing with nuclear weapons.

Mr. ROGERS. But surely it must be more specific than that.

Major SKERKER. Well, I am not really sure how much more specific I can get.

Mr. ROGERS. Well, do you have responsibility for running tests, or checking on tests; or trying to help see that we monitor properly? Do you help set ranges of exposure?

Major SKERKER. No, sir. Predominantly my functional areas of responsibility are in dealing with nuclear weapons effects and dealing with classification of materials in dealing with the atomic energy specialty program; things like that. Those are my primary responsibilities.

Mr. ROGERS. Well, if you would set forth in the record for us what your specific duties are, and how many people are assigned to carry out those responsibilities.

[The following information was subsequently received for the record:]

Major SKERKER. Mr. Chairman, my specific duties are as follows. Except where indicated, I am the only officer assigned to the Nuclear Division to perform these tasks.

Review, for the Nuclear Division, of technical documents related to Comprehensive Test Ban Treaty (CTBT) negotiations.

Review of nuclear weapons information for classification purposes. This includes briefings, documents and release of information to various commands.

Act as the Nuclear Division point of contact for nuclear weapons effects information and as the alternate member to the Military Liaison Committee to the Department of Energy.

Monitor for the Nuclear Division the Enewetak Cleanup project.

Handle, with one other individual, questions regarding nuclear weapons publications.

Process actions concerning Emergency Destruction Systems.

Act as staff point of contact for the Atomic Energy Specialty program.

Act as an action officer in coordination of joint papers regarding nuclear weapons. In the tactical nuclear areas, there are four other people that handle joint papers.

Mr. ROGERS. Now, last week we wrote to Secretary of Defense Brown, requesting the release of some classified documents containing the final operation reports for Desert Rock I through VI, from 1951 to 1955. Do you have that information with you today?

[The letter referred to follows:]

NINETY-FIFTH CONGRESS

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Congress of the United States
House of Representatives
Subcommittee on Health and the Environment
of the
Committee on Interstate and Foreign Commerce
Washington, D.C. 20515

ROOM 2415
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Room 2424
225-5995

January 12, 1978

Honorable Harold Brown
Secretary
U. S. Department of Defense
The Pentagon
Washington, D. C. 20301

Dear Dr. Brown:

The Subcommittee on Health and the Environment will conduct hearings on the potential link between leukemia and other cancers and the participants and observers of atomic blasts conducted by the United States Government between 1946 and the present. Because of the Department of Defense's participation in the nuclear weapons testing program, your testimony before the Subcommittee is requested on January 25, 1978.

The Subcommittee will explore numerous areas of concern and you should be prepared to respond to questions relating to the following:

1. The scope of the Department of Defense involvement in the nuclear weapons testing program conducted by the U. S. Government from 1946 to the present;

2. The numbers of DOD personnel (including all military services) involved in all such tests, either as participants or observers, civilian or military, and the nature and extent of their involvement;

3. The dangers to health, both to DOD personnel at the blast site and to those removed from the blast site, including the extent of radiation exposure incurred by both groups;

4. A review of measures taken before, during, and after nuclear tests to insure the

protection of the health of participants, observers; and

5. Defense Department involvement in subsequent studies investigating alleged health effects, particularly cancers, resulting from these nuclear blasts.

While particular attention will be focused on the so-called "Smoky" shot (August 31, 1957) and the entire "Plumbob Series," March 1957 to October 1957, your testimony should deal with the entire test program and its public health consequences.

In accordance with Committee rules, five copies of your testimony must be forwarded to the Subcommittee (Room 2424, Rayburn House Office Building) no later than 10:00a.m., January 20, 1978; an additional 75 copies of your statement, at least one of which must be typed on legal size paper, must be provided prior to your oral presentation before the Subcommittee.

If you have any questions concerning the hearings, your testimony or other matters relating to this hearing, please contact Steve Connolly, Burke Zimmerman, or Bob Maher of the Subcommittee staff.

Kind regards.

Sincerely yours,

PAUL G. ROGERS, M. C.
Chairman

PGR:lsr

Mr. HAAS. Mr. Chairman, the original classification and therefore the declassification and review of those reports you requested are the responsibility of other departments, the Department of the Army and Department of the Navy. The Defense Nuclear Agency has requested those agencies to reclassify and/or declassify if possible all of these as a high priority item. In the meantime, I understand they have been offered to the committee on a classified basis.

Mr. ROGERS. Well, why should they be classified?

Mr. HAAS. Well, they were classified at the time.

Mr. ROGERS. Well, that happens all the time in the service. I was in the service, too; we always used to classify everything.

Mr. HAAS. That is correct, sir.

Mr. ROGERS. But is there any reason for these to be classified?

Mr. HAAS. I strongly believe, Mr. Chairman, that there is very little if any classified information in them. I believe the committee should have them available as unclassified very shortly.

Mr. ROGERS. Have you met any resistance from any unit that you have requested them from?

Mr. HAAS. Absolutely not.

Mr. ROGERS. Could you give us a time element as to when we could expect them?

Mr. HAAS. I would think, Mr. Chairman, that they should be made available within a week.

Mr. ROGERS. That would be helpful to the committee. Thank you.

I think it would be helpful if we could also have a copy of the document known as DASA-1251, which has more complete fallout reports, I believe, on those blasts, than any other document.

Mr. HAAS. 1251?

Mr. ROGERS. I believe that is correct. DASA-1251.

Mr. HAAS. That would be a document, sir, under the cognizance of my agency, and I will see that is done.

Mr. ROGERS. That would be helpful if we could have that. Thank you.

Dr. Carter?

Mr. CARTER. Thank you, Mr. Chairman.

I noticed, Major, that you speak of radiation safety levels. What are those levels? What is a safe level of exposure to radioactivity?

Major SKERKER. Today, under the guidelines of the NCRP it is 5 rem per year, 3 rem for 13 consecutive weeks.

Mr. CARTER. Five rem per year total, then. For the military, what do you consider to be a safe exposure. The same 5 rem per year?

Major SKERKER. I have really no choice but to accept what our scientists say in terms of radiation.

Mr. CARTER. I believe you stated that in this operation, when you approached a five-tenths rem area, then you considered that unsafe?

Major SKERKER. No; I am saying that if you went beyond 500 mrem per hour.

Mr. CARTER. What is the difference between five-tenths of a rem and 500 MREM?

Major SKERKER. 500 mrem per hour is the rate and intensity, 500 mrem is total accumulation. If I stayed 1 hour——

Mr. CARTER. But, am I not correct that there is no difference between 500 mrem and five-tenths of a rem.

Major SKERKER. Oh, no difference between 500 mrem and five-tenths of a rem.

Mr. CARTER. I notice in the DOD testimony this afternoon the reference to having the National Research Council do the broad, followup study on the military participation in the atomic testing program. Why was that particular group chosen for this?

Dr. MCINDOE. The referral to the National Research Council was the considered opinion of each of the agencies that participated in the initial evaluation back in June, and again in a review that occurred prior to the time of the Surgeon General requesting Health Affairs to do this, and again in November and December. The reason being that they have the ongoing capability to do a epidemiologic study of this type.

Mr. CARTER. Do they have expertise in statistical evaluations?

Dr. MCINDOE. Very definitely.

Mr. CARTER. In epidemiology, have they done as good a job as the Center for Disease Control in Atlanta?

Dr. MCINDOE. I would think they are a very reputable organization, sir. The follow-on agency is the agency which is dealing with the long-term radiation studies of the Japanese, the Marshallese, et cetera.

Mr. CARTER. As I understand it, the National Research Council has not done any work yet on the Plumbbob series.

Dr. McIndoe. No, sir.

Mr. Carter. Have they issued any reports on any plans for the larger study?

Dr. McIndoe. They have been asked to develop——

Mr. Carter. It remains unclear to me why the DOD would want to take the study of the military participants away from CDC, and why it thinks the National Research Council is a better agency for doing the study.

Dr. McIndoe. May I answer the first question first?

Mr. Carter. Yes, sir.

Dr. McIndoe. There has been no intention at any time to remove anything from the Center for Disease Control. It has been agreed from the day they first made contact that we would support them and give them as much information as we can on Smoky.

Mr. Carter. Yes; I noticed that.

Dr. McIndoe. The expansion of the investigations into the atmospheric testing program was felt to be within the purview of the National Research Council as an appropriate area to study this; and in contact with Dr. Caldwell and Dr. Foege it was the impression I had from them that they did not wish to expand the study but limit it to Smoky.

Mr. Carter. All right. Can you tell me why this Government ended these atomic tests in the atmosphere?

Dr. McIndoe. If I recall correctly, sir, from history, it was the Limited Test Ban Treaty which restricted such testing on the basis of the fact that the atmospheric pollution was rising, and no further atmospheric testing was to be done.

Mr. Carter. Then we recognized the fact that it was dangerous to explode nuclear devices in the air; is that not correct?

Dr. McIndoe. Very definitely.

Mr. Carter. I noticed that you spoke of possibly a third group in describing the action at the Nevada tests, but you did not name it. It seems to me that there should have been a commander in chief, a director, a coordinator, some single person in charge of the whole effort. Was there no such man in this series of blasts called Plumbbob?

Mr. Haas. Yes, Dr. Carter.

Mr. Carter. Then there was one man. Who was he?

Mr. Haas. He was the test manager of the Atomic Energy Commission. He was then, and has ever since been the final authority on all nuclear device tests or weapons tests.

Mr. Carter. Then, should that person not have had in his possession records of every man who was there? You know that a general in the field usually knows, or should know, where every company and every man he has is, and he has records of that.

Mr. Haas. In fact, Dr. Carter, the test manager does for all those participants of the Atomic Energy Commission, its contractors, and the Department of Defense participants, other than troop exercises. It is only for the troop exercises that the test manager gave that authority and the recordkeeping, and in 1957 the dosimetry over to the commanding general 6th Army.

Mr. Carter. Then, I don't understand why do we not have those records now. Why are they not readily available?

Mr. Haas. We have been trying, Dr. Carter.

Mr. CARTER. You have been trying and do not have them? You do not have the records of the men who were there with the Army? That is deplorable. My goodness gracious, you mean to tell me that our Army did not account for each man who had been exposed to radiation in such an operation as this?

Major SKERKER. We have, sir, the dosimetry records for everyone who was involved at Camp Desert Rock under the 6th U.S. Army for 1957.

Mr. CARTER. You do have that?

Major SKERKER. Yes, sir, those are the microfilm records I referred to before, at the Lexington Army Signal Depot.

Mr. CARTER. You have them there. What about the other shots, do you have them also?

Major SKERKER. No, sir.

Mr. CARTER. You do not. Why not?

Major SKERKER. First off, in some instances—as I indicated in my statement—not everyone received an individual film badge. The badge was allocated one per squad, one per busload of observers, and things like that. Those records were not maintained in a central repository, they were processed by the Armed Forces special weapons project, sent through the Camp Desert Rock surgeon, who then forwarded them to the individual's home station for inclusion in his medical records. Now, that means in order to compile all those dosimetry——

Mr. CARTER. Oh, what a tangled web did we weave at that time. I submit that I've heard about that.

I would like to ask you about Baneberry. Are you familiar with that exposure?

Mr. HAAS. Dr. Carter, Shot Baneberry was a shot completely under the control of the Atomic Energy Commission.

Mr. CARTER. Did anybody in the United States participate in it, the Army, Navy, Marine Corps, Air Force?

Mr. HAAS. The Department of Energy, Dr. Carter.

Mr. CARTER. The Department of Energy? There was not a Department of Energy when Baneberry exploded.

Mr. HAAS. The Atomic Energy Commission, or Energy Research and Development Administration.

Mr. CARTER. All right, sir. Do you, or do they have statistics on that?

Mr. HAAS. I do not. I think they do, sir.

Mr. CARTER. Well I understand that 13 guards were exposed to radiation from Baneberry, and 3 of them have leukemia.

Thank you, Mr. Chairman.

Mr. ROGERS. Mr. Walgren?

Mr. WALGREN. Major Skerker, I am just a little interested in what else you are doing for your Department at present. If you were to take, for example, the 80 workdays before January 1 of this year, how much of your time was devoted to gathering the records on this particular blast; how many of those 80 workdays?

Major SKERKER. I would say since the beginning of January I have probably been involved in some aspect of it, whether it be answering congressional inquiries, gathering records, or anything pertaining in my office to military participation in atmospheric testing. Probably 25, 30 percent of my time.

Mr. **WALGREN**. About 25 to 30 percent of your time since January 1977?

Major **SKERKER**. Yes.

Mr. **WALGREN**. I see. And you are the only one that is involved in responding to those inquiries that you know of, from the military standpoint?

Mr. **HAAS**. At the Department of the Army level; yes.

Mr. **WALGREN**. At the Department of the Army. So, we have then one person one-quarter time; is that right, over the last year, to develop the information that was originally raised in this case by the initial inquiries about the causing of leukemia and the possibility of increased leukemia among these personnel. Is that right?

Mr. **HAAS**. If you will permit me, Mr. Walgren, of course the Armed Forced Radiobiology Research Institute under the direction of Colonel McIndoe has had a much larger percentage of people involved in assisting CDC, in addition to the Department of the Army effort by Major Skerker.

Mr. **WALGREN**. All right, now going to the case of the 13 people that were overexposed, over 5 rads, which you came across in reviewing the records—was this just the one blast that there were 13 people that were exposed over 5 rads?

Major **SKERKER**. No, sir. The only thing I can really tell about the 10 right at this point is that they occurred prior to Smoky on Plumbbob. I do not know how many tests are involved.

Mr. **WALGREN**. Has anybody done a systematic review of all the radioactive records to see how many people may have been overexposed?

Major **SKERKER**. Well, I have indicated in my statement for the various Desert Rock series where it is reported a number of people have been overexposed. I have indicated what those are. Beyond that, if we do not have the record, we could not tell if a man was overexposed or underexposed.

Dr. **MCINDOE**. Mr. Walgren, may I address that question, please?

The computerized central listing that was developed in 1964 by the Reynolds Electrical & Engineering Co. does not have the dose by year and by name of the exposed person. Many times the names are repeated, so that if somebody received an additional dose it would appear from one year to the next, but the listed entry would not represent a summation of all dosages.

We have gone through these records, particularly with reference to Operation Plumbbob—because of our interest in Smoky and our interest in this series of tests—ascertaining the number of doses exceeding the safe amount for that series of tests on a 1-by-1 basis. It is a computer printout and you can run down the line. The largest dose that we have found to date was approximately 980 mrem, and everything else was below that. The majority of the doses were somewhere from zero to 200 mrem.

Mr. **WALGREN**. How does the 980 mrem translate into the rad figure? I am not familiar.

Dr. **MCINDOE**. Well, that would be 1,000 mrem per 1 rem.

Mr. **WALGREN**. One rem.

Dr. **MCINDOE**. The highest we had was just about 1 rem. Now, this is not in keeping with the numbers that Major Skerker gave you, which were, I believe as high as 10.

Mr. WALGREN. Did your computer printout pick up the 10 people he picked up as over whatever the limit was? I understand the major to testify that he went to the records and found 13 people, 10 plus 3, as I recall your saying, that had been overexposed. What I am wondering is, you seem to be telling me you have a computer printout where the highest reading on there is not overexposed. Is that right?

Dr. McINDOE. Well, what I am saying, sir, is that again, if somebody appeared in several different badge readings, we would not have access to that unless we had a means of identifying whether John Brown on August of this year, and John Brown in December are the same person, especially when there are 25 or 30 John Browns. I believe this is the reason on Mr. Cooper we wound up with a total dosage——

Mr. WALGREN. The 13 people you identified, Major, would be on that computer list; would they not?

Major SKERKER. Let me clarify it, sir. The computer list is the 1968 version from the Reynolds Electrical & Engineering Co. That includes AEC employees and some military that were assigned or attached either to the AEC or the Armed Forces special weapons project, not Camp Desert Rock.

The AEC has stated that there are 44 overexposures among AEC employees or people assigned or attached to the AEC. That is in addition to what I found in the Desert Rock reports, which are simply concerned with the Army, Navy, Air Force, Marines, Canadians, assigned or attached to Camp Desert Rock under the 6th U.S. Army.

Mr. WALGREN. Now, has any systematic list of those overexposed been compiled? And you have 13 in addition to what the AEC has; is that right?

Major SKERKER. That is right. They all should be in the updated version of the AEC file.

Mr. WALGREN. And what has happened to those names? They, I take it have never been notified; is that right, those people who received overexposures?

Dr. McINDOE. No; we have made no official effort to notify them.

Mr. WALGREN. And in fact, you have made no official effort to track them.

Mr. CARTER. If the gentleman would yield just for a second?

Mr. WALGREN. Yes, Dr. Carter.

Mr. CARTER. Referring to overexposures, are those three men who have leukemia from the Baneberry explosion still living?

Major SKERKER. I have no idea, sir.

Mr. WALGREN. Not only have you made no official effort to notify them, you have no official effort to keep track of them, so that they could now be gone back to and reached; is that correct?

Dr. McINDOE. No; that is not quite true, sir. Each individual who has been subject to radiation exposure in the film badge program has a Department of Defense form which records his listing of radiation exposure. This is a mandatory part of his medical record. The medical record is the official repository for an individual's radiation dosekeeping.

Mr. WALGREN. Can we get at all of these medical records?

Dr. McIndoe. We should be able to get at any of the radiation readings on those records, if the records are available, yes, sir.

Mr. Walgren. Where would those records be?

Dr. McIndoe. Pardon me?

Mr. Walgren. Where would those records be?

Dr. McIndoe. If the man is no longer on active duty they should be in the repository at St. Louis if they were not burned in the fire.

Mr. Walgren. All right, the man's record, when he gets out of the service, goes to the repository at St. Louis, and the man goes on in private life; and you have no way of knowing where he went. Is that correct?

Dr. McIndoe. Not unless he is into the federal system some way, the medical followup.

Mr. Walgren. So, we are faced with the prospect of wanting to find somebody but coming up with the difficulty that Major Skerker has had where, I take it, out of 43 men he found 8 live addresses; is that correct?

Major Skerker. That is right.

Mr. Walgren. Or, you found eight alive as of 1971, with no current addresses, I gather. Is that correct?

Major Skerker. That is right, sir.

Mr. Walgren. And one fellow who you found a telephone number for that you hope will answer the phone when you call; is that correct?

Major Skerker. That is right, sir.

Mr. Walgren. Now, the other aspect of it was, apparently we have no way of gathering a comprehensive list of those exposed at that flight. As you said, the Tennessee Air National Guard, or whoever it was, flew on out of there with no records whatsoever of who was in those airplanes. We cannot find those people; is that correct?

Mr. Haas. I would say that we have not been able to, to this date.

Mr. Walgren. Have you made an attempt?

Mr. Haas. I believe efforts have been underway, and I will certainly assure you that they will continue at an accelerated pace hereafter. But it is not an easy thing, especially since in many instances those organizations are under the control of State organizations and not the Federal Government, and frequently some of the organizations then in being are no longer in existence.

Mr. Walgren. Can you make a suggestion to the committee as to what sort of accelerated pace would be warranted by the need for this information? Apparently, and I mean to say that a problem which has resulted in the gathering of up to 24 participants from 10 agencies has warranted the one-quarter time of one individual who, I confess, is distracted by a number of other obligations he is given by the military. Can you suggest what kind of accelerated effort would be warranted under these circumstances?

Mr. Haas. Well, as we stated in our testimony, Mr. Walgren, we did have this coordination meeting now in early December, in which my agency has now been charged within the Department of Defense as the coordinator. We certainly intend to, and have already begun to put a much larger number of people on the job. In fact, it could well be that Major Skerker will join that effort within the Defense Nuclear Agency.

Mr. WALGREN. A much larger number of people. Could you give us a minimum number that you are prepared to put onto this kind of an effort in response to this committee's request?

Mr. HAAS. We are willing, Mr. Walgren, to put on as many people as the system can stand in terms of getting information. But since the information is not contained in our files, all we can do at the moment is go after the files, wherever they are. Whatever manpower it is going to take to do that, we shall make available; just as we have stated that whatever funds are required for the research by the followup agency, shall be made available.

Mr. WALGREN. Major Skerker, would you describe your role with the Department of Defense as public relations; has that word ever been used as a job description for the kinds of things you have been asked to do for the Department of Defense?

Major SKERKER. Not really.

Mr. WALGREN. I wonder why it was so difficult for you to describe, in response to the chairman's question, just what it was you do for the Department of Defense. I do not mean to be disrespectful in any way, but I would think that to have had the responsibility which you have had, which is an extremely serious responsibility from the public's viewpoint, being responsible for gathering the data that is needed by this kind of investigation, that you would be able to detail in very specific terms the kinds of things you do for the Department of Defense.

Major SKERKER. I could do that in closed session, sir.

Mr. WALGREN. I see. I am always curious to know what is going through people's minds, and when you were asked that question by Chairman Rogers a note was passed to you, and I wondered what was on that note.

Major SKERKER. I do not remember where I put it.

Mr. WALGREN. You put it in your upper right-hand pocket.

Major SKERKER. Well, it says, "Just answer the questions. Let them finish their questions, it gives you time to think."

Mr. WALGREN. Thank you.

Mr. ROGERS. That is good advice for all of us.

Mr. WALGREN. I am concerned as to who had overall reponsibility for the presence at those blasts, and what you are saying is that the AEC had overall responsibility.

Mr. HAAS. The Atomic Energy Commission, Mr. Walgren, later the Energy Research and Development Administration, now the Department of Energy has always had responsibility for the design, manufacture, and testing of all nuclear weapons.

Mr. ROGERS. Would the gentleman yield?

Let me ask you, how many other tests now, for instance, in the Pacific—to continue what the gentleman was pursuing there on names and so forth—how many have been involved in tests in the Pacific? You are telling us about what was involved in Nevada. How many other tests, and how many people were involved in tests in the Pacific?

Mr. HAAS. Mr. Chairman, referring back to my opening statement, we have come originally prepared to address only the troop test exercise involvement. As I stated, it was only last Thursday that we got the full extent of the committee's interest, which involves obviously both nuclear weapons testing—atmospheric and underground—and we are prepared to submit that information for the record when it becomes available.

To the best of my knowledge there were no troop tests involved in the Pacific tests.

Mr. ROGERS. But were people exposed to the radiation?

Mr. HAAS. There were people exposed to nuclear radiation, usually on reentry on the retrieval of scientific and technical instruments at all tests. I, myself, was a part of such tests many times, both above and underground. But I think that is a different subject matter than the one we have come prepared on. However, we will submit that information for the record when it becomes available.

Mr. ROGERS. Yes; I would hope so. Go ahead, Mr. Walgren.

Mr. WALGREN. I just wanted to go back to the thought of whether or not we could zero in on those the records that the Department would indicate were overexposed. Major Skerker, am I right in assuming that when you found the 13 that had received more than the safe rad dose, there was no indication that you know of that anyone else had found those 13; or the fact that they had been overdosed was ever noticed before your examining the records?

Major SKERKER. Well, there is no evidence that anyone noticed it after the Plumbbob series was history.

Mr. WALGREN. And is there any evidence that anyone noticed it at the time?

Major SKERKER. Yes.

Mr. WALGREN. And what evidence was that?

Major SKERKER. I will submit it for the record, sir, it is simply basically an affidavit that says these 10 individuals received between 5 and 7 rem, and that no problems were noted. That is the extent of it.

Mr. WALGREN. I would like the record held open at this point and that affidavit received.

Mr. ROGERS. Without objection it will be received.

[Testimony resumes on p. 308.]

[The affidavit and attachments follow:]

Major Skerker. A copy of the affidavit is attached. A closer review of the document listing ten individuals who exceeded 5 rem exposure and additional evidence reveals that my statement was imprecise. The enclosures referenced in the document were located on the microfilm and reveal that each of these instances involved cases wherein individuals attested either that they had never been in the forward area, or that they did not enter high radiation areas, and on the basis of their movements were adjudged to have received less exposure.

Since my testimony, another document has been found that identifies other individuals who exceeded 5 rem during the period 1951 through 1957. This list appears to include individuals associated with the AEC and Camp Desert Rock, since they were extracted from two sources, the REECO file maintained by the AEC and the microfilm records from the Lexington Army Depot. From the Lexington records, eleven individuals are listed. The three on the SMOKY list are not included in this list of eleven.

UNITED STATES
ATOMIC ENERGY COMMISSION
NEVADA OPERATIONS OFFICE
P. O. BOX 14100
LAS VEGAS, NEVADA 89114

MAY 1 1970

Martin B. Biles, Director
Division of Operational Safety, HQ
ATTN: Roy D. Maxwell, Chief, NEES
Division of Operational Safety, HQ

DESERT ROCK PERSONNEL EXPOSURE

This report is submitted in partial fulfillment of a request by Dr. Roy D. Maxwell, Division of Operational Safety, to research all available records in answer to the following questions:

a. How many troops were exposed during the Desert Rock Exercises?

b. What range of exposures did the participating troops incur?

A meeting was held March 12, 1970 with Col. R. Ray of the Military Liaison Committee, where the decision was made "to only identify military exposures which exceeded the criteria dose". With this decision only the names of military personnel whose exposure was equal to or greater than 5 rem were recorded.

This report is submitted as a preliminary report rather than a final one to allow the reporting of any additional individuals whom may be identified in yet to be located records.

In answer to the questions proposed above, the information was compiled and is reported by year and exercise as follows:

a. 1951, 1952 - Buster Jangle - Tumbler Snapper Series

Because the exercise reports for these series were not located, the exact number of participating personnel is not as yet known. Dosimetry records maintained during this period of time however, appear to be comprehensive with several thousand names identified as Desert Rock with exposures listed. These dosimetry records were obtained from Col. E. Fountain, U. S. Army during a process consolidation of exposure records at the Nevada Test Site. A review of the records indicated only five (5) individuals whose exposure exceeded 5 rem (see Enclosure 1).

b. 1953 - Desert Rock V - Upshot-Knothole Test Series

The number of military personnel who participated in nine (9) events of this series are as follows:

Army - 13,364 Navy and Marine Corps - 2,921

Air Force - 1,273

The dosimetry criteria established for this test series did not provide for individual dosimeters. Dosimetry was accomplished by issuing one film badge and one pocket dosimeter per platoon. Observers were issued one film badge per bus load.

The dosimetry for the participating troops was "apparently" performed by the test site dosimetry organization. This is assumed from a statement made in the conclusions and recommendations section of the Desert Rock V report. The statement in effect suggests that a separate dosimetry unit be assigned and made available for the participating troops in future Desert Rock exercises.

The records as maintained by Reynolds Electrical & Engineering Co., Inc. (REECo) were searched for military exposures exceeding 5 rem during 1953. Forty-one (41) individuals were identified as military personnel in excess of 5 rem (see Enclosure 1). The Desert Rock V report mentions that the 1st Battalion, 8th Marines encountered a highly radioactive area. Dosimeters carried by personnel registered more than 6R. The Battalion was subsequently removed from further test activity. To date no specific names have been identified in the records as belonging to the 8th Marines. Efforts to search the 1953 records to locate individuals as representatives of this group are continuing.

c. 1955 - Desert Rock VI - Teapot Test Series

The total number of military personnel participating in this exercise totaled 8,135. Actual troop observers directly associated with the test events are estimated to be 2,033. The Dosimetry Criteria or the issuance of film badges is as follows:

(1) One badge per permanent party observer.

(2) One badge per VIP.

(3) One badge per squad of official observers.

(4) One badge per tank crew.

(5) One badge per individual not in a group.

There has been no comprehensive dosimetry record of the Desert Rock participants located for exercise Desert Rock VI at this date. In the Desert Rock VI report under the Appendix entitled "Signal Corps", statements are made describing the presence of two photo vans and the processing of 7,500 film badges. Statements were made telling that the photo team also handled the photo dosimetry. From this information, it is believed that the complete record for this exercise is stored somewhere with the records of the Signal group who performed the photo coverage. The list of participating agencies in the Desert Rock VI report makes mention of a 232nd Signal Company. This group is the likely candidate for possessing the dosimetry records of interest for 1955. Enclosure 1 lists those military personnel with greater than 5 rem exposure as extracted from the records maintained by REECo.

See Enclosure 3 for the listing of agencies and personnel contacted in attempting to locate the 1955 dosimetry records.

The following exposure summary was extracted from the Desert Rock VI report.

97 persons received >3R < 6R

15 persons received >6R < 20R

2 persons received >20R

d. 1957 - Desert Rock VII and VIII - Plumbbob Series

The total number of participating military personnel was 20,103. Actual event related personnel is believed to be closer to 6,218. The dosimetry criteria during these exercises called for film badging of each individual involved in the operation.

The dosimetry support was provided by the Sixth U. S. Army Signal Nucleonics Branch, Lexington Signal Depot, Lexington, Kentucky. The dosimetry records were located at Lexington. The records were retrieved, examined and eleven (11) individuals were listed in excess of 5 rem (see Enclosure 2).

Exposures of military personnel extracted from REECo's dosimetry records for the Plumbbob Series are listed in Enclosure 1. All these individuals were from Kirtland Air Force Base, New Mexico.

Robert E. Miller
Manager

ORB:BMC-353

Enclosures:
1. Individuals Exceeding
   5 rem
2. Individuals Exceeding
   5 rem for 1957
3. Agencies and Persons
   contacted

cc: Col. Roger Ray, Military
    Liaison Comm., HQ, w/encls.

HEADQUARTERS
CAMP DESERT ROCK
Las Vegas, Nevada

15 August 1957

SUBJECT: Board of Investigation

TO: Commanding General
Camp Desert Rock, Nevada

1. By [illegible] par 8, SO #76 Hq, Camp Desert Rock, Nevada, dated [illegible] July 1957 the Investigation Board appointed to investigate all cases of film badge readings of five (5) or more roentgens and violations of Memorandum [illegible], Camp Desert Rock, Nevada, dated 8 May 1957, as corrected, met [illegible] of July 1957 and again at 0930 hours 14 August 1957. (See Incl [illegible])

MEMBERS PRESENT	MEMBERS ABSENT
MAJ Franklin A. [illegible]	NONE
[illegible]	
[illegible]	

2. The Investigation Board reviewed two incidents involving film badge readings of five (5) or more roentgens and violations of Memo 8, and the report follows which includes findings and recommendations for each individual case.

10 Incls
[illegible]

FRANKLIN A. [illegible]
Major QMC
President

1. UP Par 8, SO 74, Hqs, CDR, DTC 13 Jul 57 [illegible] convened radiation board was held concerning the following case:

The nonissuance of a dosimetry film badge to SP-3 Cecil [illegible], RA [illegible], 96 Army Garrison 6012-03, Camp Desert Rock, from period 9 May thru 20 June 1957.

2. Discussion: During period that subject EM was in process of clearing for departure from this station, it was discovered that no film badge had been issued to him, during his tour at Camp Desert Rock either by his unit, instructor group or II where he worked while at Camp Desert Rock. Investigation revealed that subject EM was never issued a Nevada Test Site badge nor did he ever enter the Nevada Test Site area. In this connection see attached statement. Background radiation at Camp Desert Rock during period indicated was 5 mr.

3. Findings: That a violation of radiological safety procedures UP Memorandum 8, this Hqs, was committed in that subject EM was not issued a film badge during his tour at Camp Desert Rock through neglect of his unit and staff section.

4. Recommendations: That all units and Staff Sections exercise constant supervision of their personnel to insure that they have film badges at all times while at Camp Desert Rock. In addition, recommend that the CO of US Army Garrison 6012-03 insure that newly arrived personnel are issued a film badge as soon as practical. That the reading of 5 mr for period 9 May thru [illegible] be entered on subject EM's Record of Exposure to Ionizing Radiation, DD Form 1141.

[illegible]

C. L. KIRK
Capt, [illegible]
[illegible]
Member

CHARLES [illegible]
1st Lt, [illegible]
[illegible]
Recorder

19 June 1957

STATEMENT

I Sp-2 Cecil A O'Leary RA 19 272 647 was never in a Forward area of the Nevada Test Site and was never inside the main gate at Camp Mercury while on TDY at Camp Desert Rock Nevada, between the dates 9 Apr 1957 the date of my arrival and 19 June 1957, date of departure. Further more I state that I was never badged for entry to Camp Mercury, Nevada nor for any Forward area.

/s/ Cecil A O'Leary
/t/ CECIL A O'LEARY
Sp-2 RA 19272647

1. UP Par 6, SO 76, Hqs, 6th, DTD 10 Jul 57 an investigation board was held concerning the following case:

The nonissuance of a dosimetry film badge to PVC James E. [illegible], RA [illegible] 276 0[illegible], US Army Garrison (6010-03), Camp Desert Rock, from period 8 June thru 27 June 1957.

2. Discussion: During period that subject was in process of clearing for departure from this station, it was discovered that no film badge had been issued to him, during his tour at Camp Desert Rock either by his unit or the Aviation Section where he worked. Investigation revealed that subject not only was never issued a Nevada Test Site badge nor did he ever enter the Nevada Test Site area. In this connection see attached statement. [illegible] at Camp Desert Rock during period indicated was [illegible].

3. [illegible]. That a violation of radiological safety procedures by [illegible] that subject was not issued a [illegible] at Camp Desert Rock through neglect of his unit [illegible]

4. [illegible]. That all units and staff Sections exercise constant [illegible] to insure that they have film badges at all [illegible] Camp Desert Rock. In addition, recommend that the CO of US [illegible] insure that newly arrived personnel are issued a film badge [illegible]. That the reading of [illegible] for period 8 June thru [illegible] be entered on subject's [illegible] Record of Exposure to Ionizing Radiation [illegible].

[illegible]

O. J. KIRK
[illegible]
[illegible]
Member

CHARLES [illegible]FORD
1st Lt, [illegible]
[illegible]
Recorder

[illegible] SECTION
[illegible]

30June 1957

I, [illegible] hereby certify that while I was stationed at Camp Desert Rock, Nevada, I did not go into the forward area at any time. To the best of my knowledge, I did not become exposed to any radioactive material.

[illegible] E. Sagre
[illegible] RA24276079

Robert V. [illegible]
1st Lt, Infantry

1. UP Par [illegible] SO 76, Hqs, C.R., DTD 10 Jul 57 an investigation board was held concerning the following case:

The dosimetry film badge (W106) issued to Pvt Walter L. [illegible], US 53 264 219, Btry C, [illegible] FA Bn, Camp Desert Rock, during period 6 June through 26 June 1957, which was determined to have been exposed to light, thereby damaging the film.

2. Discussion: See attached subject letter from Office of The Dosimetry Team, Camp Desert Rock, regarding investigation conducted by that section. Subject EM's statement is also attesting to the fact that he did not enter the Nevada Test Site. Background radiation at Camp Desert Rock during period indicated was 5 mr.

3. Findings: Attached letters are accepted per se. Circumstances affecting "light exposure" are unknown.

4. Recommendations: That the reading of 5mr for the period 6 June through 26 June 1957 be entered on subject EM's Record of Exposure to Ionizing Radiation, DD Form 1141.

[illegible] A. KIRK
[illegible]
[illegible]
President

C. [illegible] KIRK
Capt, MSC
[illegible]
Member

Charles [illegible]
CHARLES [illegible]
1st Lt, SigC
[illegible]
Recorder

STATEMENT

I, PVT Walter L. Tynes, US 53 269 249, did not at any time enter the "Forward Area, Nevada Test Site", prior to 29 June 1957. I did not handle any chemicals prior to this time nor did I permit my film badge to become wet. I did not tamper with my film and to the best of my knowledge did anyone else.

s/Walter L Tynes
WALTER L TYNES
Pvt-2 US53269249

HEADQUARTERS
CAMP DESERT ROCK
Las Vegas, Nevada
Office of the Dosimetry Team

2 July 1957

SUBJECT: Damaged Film W 106

THRU: Signal Officer
Camp Desert Rock, Nevada

TO: Radiation Safety Officer
Camp Desert Rock, Nevada

1. On 28 June 1957 a group of dosimetry film containing film number W 106 was processed for Project 50.8. W 106 was very dense indicating the possibility of severe gamma radiation exposure. If this had been the cause, the dose received would have been 735 roentgens.

2. The dosimetry team performed a through investigation in order to determine the actual cause of this unusual amount of density. In this investigation one hundred film were exposed in an attempt to simulate the characteristics exhibited by W 106. Upon completion of this investigation it was the definite opinion of the team that no dose of radiation whatsoever was received by the person wearing W 106. The cause of the excess density of W 106 was determined to have been light exposure.

/s/ Clarence O Slover
/t/ CLARENCE O SLOVER

A TRUE COPY:

C. J. KIRK
Capt, MSC

CERTIFICATE

I, CWO George A. Schneider, Maint. Officer, 529th FA Bn, (on duty with Hq & [illegible] FA Bn, Project 50.6, Camp Desert Rock, Nevada) certify that to the best of my knowledge and belief Pvt [illegible] Spence, US 53 249 [illegible], a member of my Metro Section, [illegible] Nevada Testing Grounds, at any time [illegible]

George A Schneider
GEORGE A. SCHNEIDER
CWO (W 3) USA

1. UP Par 4, SO 76, Hqs, [illegible], NT, 10 Jul 57 an investigating board was held concerning the following case:

The non-issuance of a dosimetry film badge to SP3 [illegible] Lorna De Vittoria, RA 30 [illegible] 393, US Army Garrison (6019-00), Camp Desert Rock, from period 15 May 1957 through 30 July 1957.

2. Discussion: Subject EM requested a film badge from the Rad-Safe Section on 30 July 1957. It was discovered at that time that he had never been issued a film badge since his arrival at this station on 15 May 1957, by his unit or the Quartermaster Section where he worked. Investigation revealed that subject EM was never issued a Nevada Test Site Badge nor did he ever enter the Nevada Test Site area. Background radiation at Camp Desert Rock during period indicated was 7 mr. (See Incl)

3. Findings: That a violation of radiological safety procedures, UP Memorandum 8, this Hqs, was committed in that subject EM was not issued a film badge during his tour at Camp Desert Rock through neglect of his unit and staff section.

4. Recommendations: That all units and Staff Sections exercise adequate supervision of their personnel to insure that they have film badges at all times while at Camp Desert Rock. In addition, recommend that the CO of US Army Garrison (6019-00) insure that newly arrived personnel are issued a film badge as soon as practical. That the reading of 7 mr for period 15 May 1957 through 30 July [illegible] be entered on subject EM's Record of Exposure to Ionizing Radiation, DD Form 1141.

[illegible] [illegible] [illegible]
Maj, [illegible]
[illegible]
President

C. W. [illegible]
Capt, MSC
[illegible]
Member

Charles Bradford
CHARLES BRADFORD
1st Lt, SigC
[illegible]
Recorder

1. [illegible]

[illegible]

2. [illegible] Subject [illegible] requested a film badge from the [illegible] on 10 August, [illegible]. It was discovered at that time that he had never been issued a film badge since his arrival at this station on 15 May 1957, by his unit or the staff Section where he worked. Subject M was questioned by the Board and made a statement which is attached. Investigation revealed that subject M was never issued a Nevada Test Site Badge nor did he ever enter the Nevada Test Site area. Background radiation at Camp Desert Rock during period indicated was 7 mr.

3. Findings: That a violation of radiological safety procedures IAW Memorandum 6, this Hqs, was committed in that subject M was not issued a film badge during his tour at Camp Desert Rock through neglect of the unit and staff section.

4. Recommendations: That all units and staff sections exercise close supervision of their personnel to insure that they have film badges at all times while at Camp Desert Rock. In addition, recommend that the CO of the Army Garrison 6029-05 insure that newly arrived personnel are issued a film badge as soon as practical. That the reading of 7 mr for period 16 May 1957 through 10 August 1957 be entered on subject M's Record of Exposure to Ionizing Radiation, DD Form 1141.

[illegible]

[illegible]

[illegible]

[illegible]

STATEMENT

[illegible] James C. Reddoch, US 56 282 2[illegible], US Army [illegible], [illegible] at Camp Desert Rock, Las Vegas, Nevada on or about [illegible] 1957. I arrived with Pvt Charles Cox and Pvt [illegible] who were assigned to work in the Supply Section of Det #3 while I was assigned to [illegible] the Post Engineer's Section as a warehouseman. On or about 1 June 1957, we arrived Capt Kennedy spoke to the group which included Pvts [illegible] about passes, leave and off limits places. Nothing [illegible] a Film Badge.

[illegible] August 1957 a few individuals I knew were asked if they wanted to go [illegible] to see the Smoky Shot. So I wanted to see a shot and I wanted [illegible] and went to find out I needed a Film Badge in order to [illegible] of shot. I had not been issued a Film Badge since I [illegible] to Camp Desert Rock, while my two friends Pvts Cox and [illegible] their Film Badge about three (3) weeks after arrival at Camp Desert Rock.

[illegible] never been in the Forward Area for any reason [illegible] my duty at Camp Desert Rock.

[illegible] the Post Engineer's Section questioned me about what [illegible] Film Badge.

[illegible] this duty to myself until about three (3) weeks ago [illegible] assigned to assist me.

Since I have been here I have been friendly and associated with Pfc Paul [illegible], US 52 425 514 and Pfc John [illegible] Brown II [illegible] for the Chaplain Section, during the same time I have been here.

/t/JAMES C. REDDOCH
Pvt Det 3
/s/James C. Reddoch

True copy
C J Kirk
C. J. Kirk
Capt, MSC

1. IAW Par 4, SO 76, Hqs, CRD, dtd 10 Jul 57, an investigating [illegible] board was held concerning the following case:

The film badge ([illegible]) issued to 1st Lt. [illegible] [illegible], [illegible] Signal Platoon (Sv), which was accidentally exposed during period 24 June through 5 July 1957. Determination to be made as amount of radiation to be entered on permanent records.

2. Discussion: The board questioned Mr. [illegible] Glover from the [illegible] branch of the [illegible] Signal [illegible] who is chief of the photo-dosimetry section at CRD. Mr. Glover states that the film was accidentally exposed and that no true reading could be made as to the actual amount of radiation received by the subject officer, but the officer did not appear to have been [illegible] with. Blood tests were taken at the Camp Dispensary and showed no change in the blood chemistry. While in the forward test site area, Lt Garcia was in the company of Capt Peterson. (See attached certificate)

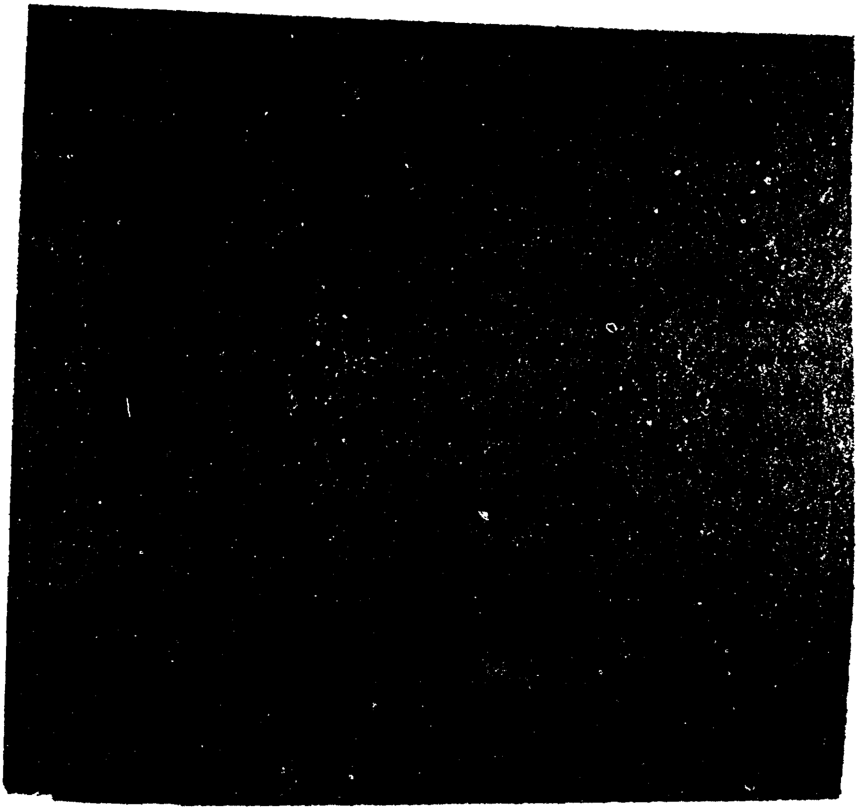
3. Findings: That the film was accidentally exposed as stated through circumstances unknown.

4. Recommendation: That the reading of [illegible] milliroentgens for the period 24 June through 5 July be entered on subject officer's record of Exposure to Ionizing Radiation, DD Form 1141.

[illegible]
[illegible]
[illegible]

C. [illegible]
Capt, [illegible]
[illegible]
Member

CHARLES [illegible] D
1st Lt, [illegible]
[illegible]
Recorder



[illegible] Hq, [illegible] dt 10 Jul 57, to investigate [illegible] concerning the following [illegible] film badge [illegible] issued to 1st Lt [illegible] (Cml), which was accidently exposed [illegible]. Information to be made [illegible] to be entered on permanent records.

2. **Discussion:** The board questioned Mr. Clarence Glover from the [illegible] branch of the Lexington Signal Depot, who is Chief of the Photo-dosimetry Section at OCR. Mr. Glover stated that the film was accidently exposed and that no true reading would be made as to the actual amount of radiation received by the subject officer. The film holder did not appear to have been tampered with. Blood tests were taken at the Camp Dispensary and showed no change in the blood chemistry. While in the forward test site area, Lt Meyer was accompanied by Marine [illegible] Bruce L. Mims of the 4th Marine Corps (Prov). ([illegible] 10 Form showing amount of radiation received by Sgt Mims is attached)

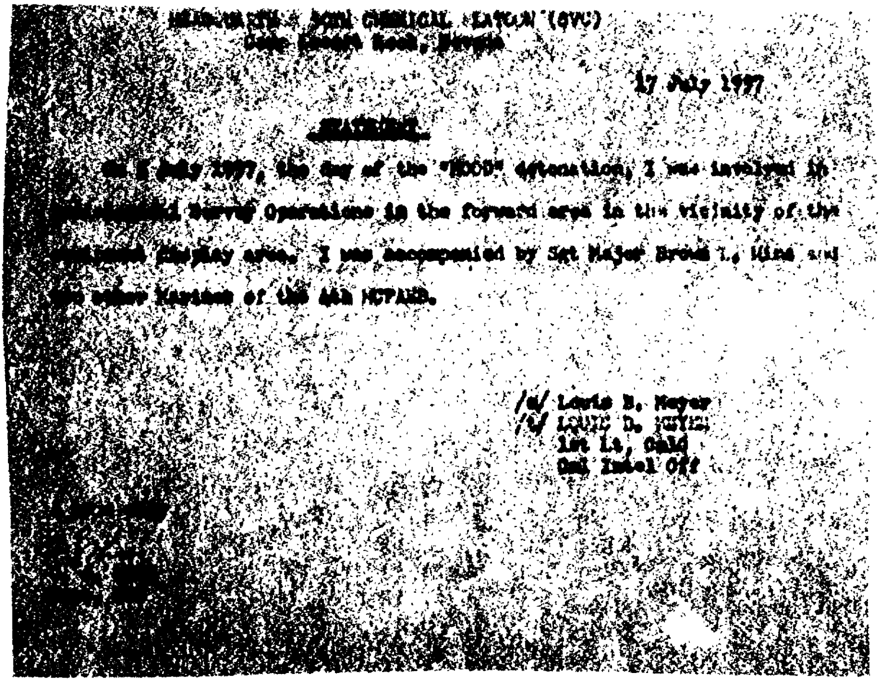
3. **Findings:** That the film was accidently exposed as stated through circumstances unknown.

4. **Recommendation:** That the reading of 2400 mr for the period 24 June through 5 July be entered on subject officer's Record of Exposure to Ionizing Radiation, DD Form 1141.

FRANKLIN [illegible]
Maj, CmlC
O1284576
President

C. J. [illegible]
Capt, MSC
O2263692
Member

[illegible]
1st Lt, SigC
OR941358
Recorder



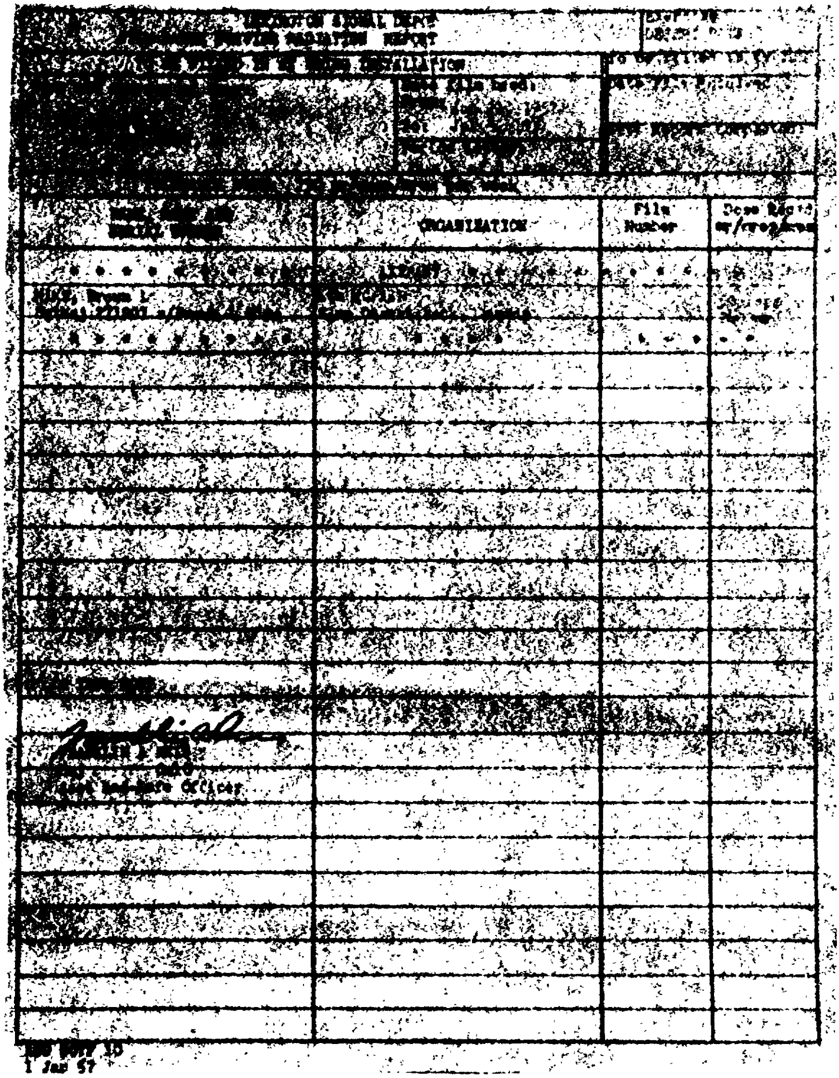
HEADQUARTERS [illegible] CHEMICAL PLATOON (SVC)
Camp Desert Rock, Nevada

17 July 1957

STATEMENT

On 5 July 1957, the day of the "HOOD" detonation, I was involved in Radiological Survey Operations in the forward area in the vicinity of the [illegible] display area. I was accompanied by Sgt Major Brown L. Hine and two other Marines of the 4th MCPAEB.

/s/ Louis D. Meyer
/t/ LOUIS D. MEYER
1st Lt, CmlC
Cml Intel Off

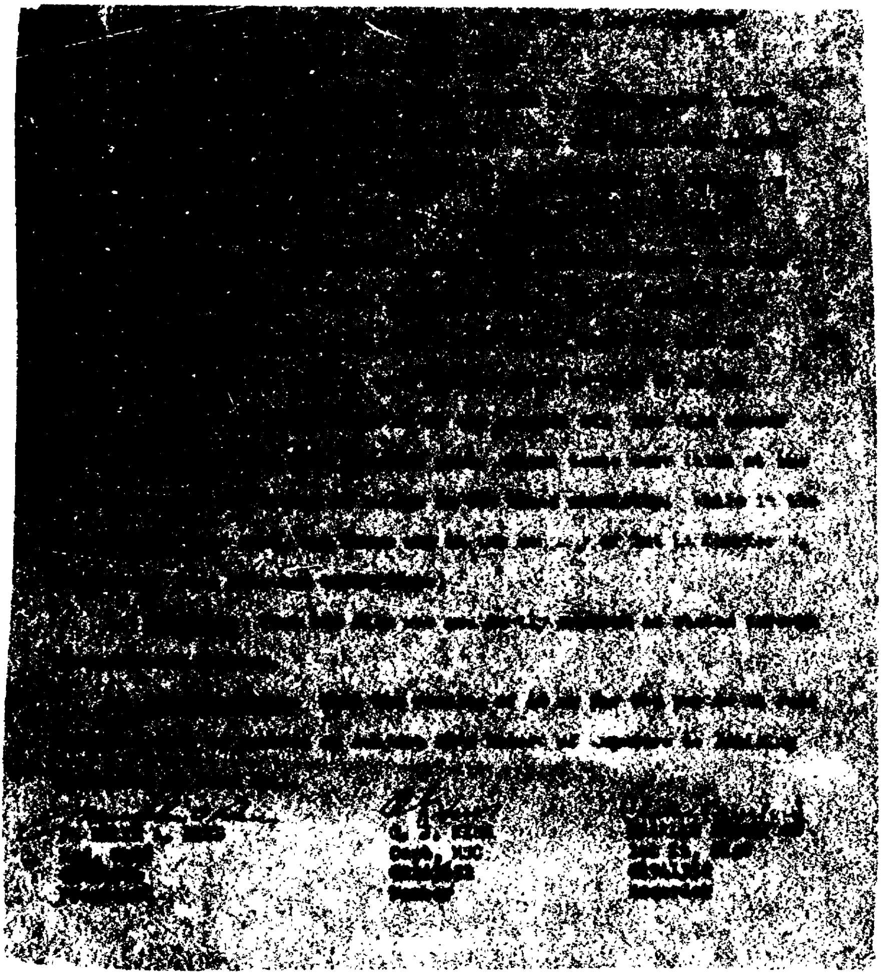


[illegible] SIGNAL DEPOT
[illegible] RADIATION REPORT

[illegible]	ORGANIZATION	File Number	Dose Rec'd mr/[illegible]
[illegible]	[illegible]		
[illegible]	[illegible]		[illegible]

[illegible]
[illegible] Officer

[illegible] 15
1 Jan 57



C-E-R-T-I-F-I-C-A-T-E

I certify that SFC [illegible] [illegible], RA [illegible], 50th Chemical Platoon (Svc), Camp Desert Rock, Nevada, accompanied the undersigned as a radiological monitor during the period 0830 - 1130, 5 July 1957.

At no time during this period did we enter an area in which the radiation dose-rate exceeded 30 mr/hr. My cumulative dosage for the period 24 June thru 5 July 1957 was 40 milli-roentgens.

CHARLES W. PE[illegible]
019[illegible]38
1st Lt, Cml [illegible]

[illegible] by [illegible] Hq [illegible], CYS, [illegible] 10 Jul 57 to investigate [illegible] [illegible] [illegible] concerning the following cases:

The nonissuance of a dosimetry film badge to PFC Robert [illegible] [illegible], RA [illegible] and PFC Donald L. Smith, RA 13[illegible], 53[illegible] [illegible] Det, Camp Desert Rock, from period 17 July 1957 through 30 July 1957.

2. **Discussion:** Subject EM requested film badges from the Rad-Safe Section on 30 July 1957. It was discovered at that time that they had never been issued a film badge since their arrival at this station on 17 July 1957, by the 53[illegible] [illegible] Det. Investigation revealed that subject EM were never issued a Nevada Test Site Badge nor did they ever enter the Nevada Test Site Area. Background radiation at Camp Desert Rock during period indicated was 7 mr. (See Incl)

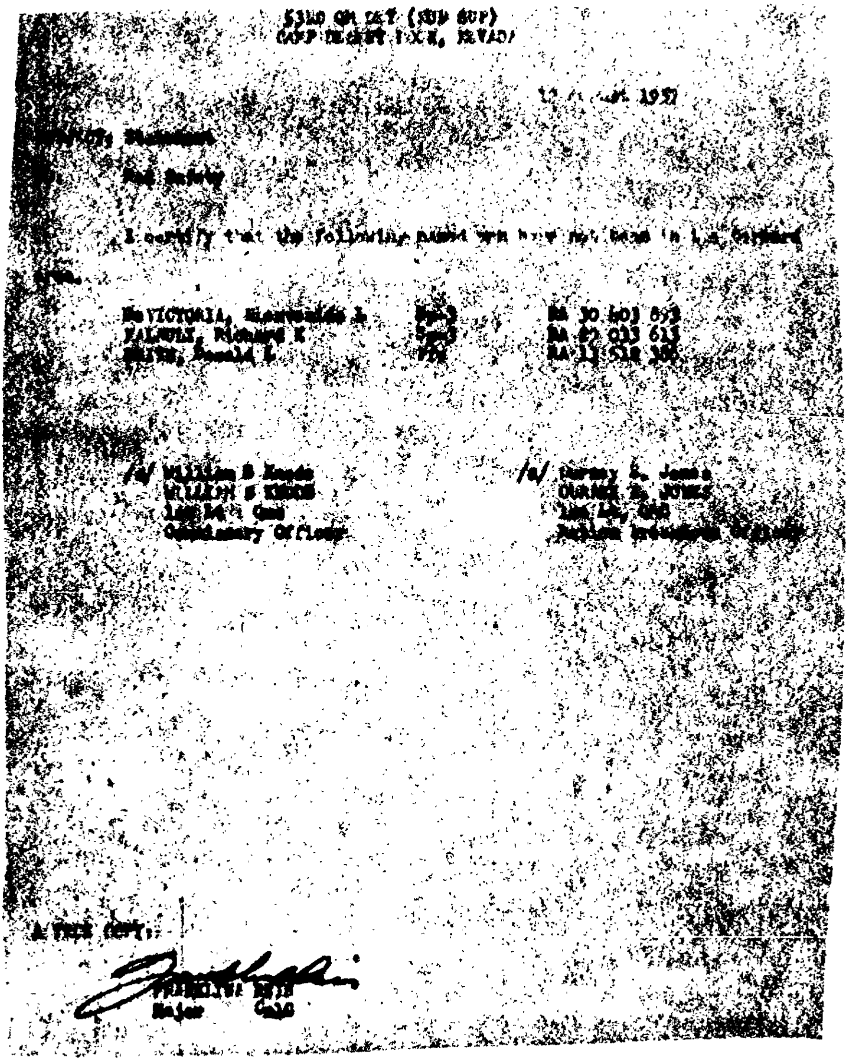
3. **Findings:** That a violation of radiological safety procedures of Memorandum 6, this Hq, was committed in that subject EM was not issued film badges during their stay at Camp Desert Rock through [illegible] of their unit and staff sections.

4. **Recommendations:** That all units and staff sections exercise [illegible] supervision of their personnel to insure that they have film badges at all times while at Camp Desert Rock. In addition, recommend that the CO of 53[illegible] [illegible] Det insure that newly arrived personnel are issued a film badge as soon as practical. That the reading of 7 mr for the period 17 July 1957 through 30 July 1957 be entered on subject EM's Record of Exposure to Ionizing Radiation, DD Form 1141.

FRANKLIN A. [illegible]
Maj, CmlC
[illegible]
President

C. J. [illegible]
Capt, MC
0263652
Member

[illegible]
1st Lt, [illegible]
0194[illegible]
Recorder



53RD QM DET (SUP SUP)
CAMP DESERT ROCK, NEVADA

12 [illegible] 1957

SUBJECT: Statement

TO: Rad Safety

I certify that the following named men have not been in the forward area.

De VICTORIA, [illegible] A.	Pvt-2	RA 30 403 693
[illegible], Richard E	Pvt-2	RA 67 033 613
[illegible], Donald E	PFC	RA 13 526 380

/s/ William B [illegible]
WILLIAM B [illegible]
1st Lt, QMC
Commissary Officer

/s/ Harvey L. Jones
HARVEY L. JONES
1st Lt, QMC
[illegible]

A TRUE COPY:

[illegible]
Major QMC

INDIVIDUALS EXCEEDING 5 rem

	NAME	ORGANIZATION	mrem
1951	GIBSON, Thomas A.	ETG-6	5080
	JESSUP, M. E.	Desert Rock	5800
1952	KREGLOH, Edwin R.	4924th KAFB	6930
	LANE, David C.	126 Chem Service Co.	6100
	UEBERSOHN, Glenn R.	Test Command	10815
1953	ALLEN, Alton C.	NMRI	7045
	ANDRADE, Antonio R.	Fort McClellan, Alabama	7755
	AVERY, D. B.	Air Force (WPAFB)	5000
	BARNES, L. M.	Air Foce WADS (WADC Convair)	8060
	BLANCHARD, L. C.	4925th T. G. (4925th TGA)	14660
	BROWN, Floyd J. D.	Fort McClellan, Alabama	6500
	BROWN, Frank W.	1090th RPTG SP/GP, U.S.A.	6390
	BRUNSWICK, A. D.	Air Force - WP AFB	6350
	CAREY, N. S.	U. S. Navy	6060
	CHAMBERS, F.	YAFB Air Force	5100
	CLARK, Wilbur L.	Air Force - WPAFB	7150
	COSTABILE, Eugene A.	Fort McClellan, Alabama	16769
	CRESS, Walter	AMPH Coronado, California	6620
	DAVISON, Clark E.	Lowrey AFB	5170
	DeWITT, Eirvin Jr.	DWET	7525
	DUCKSWORTH, Blane	Fort McClellan, Alabama	5590
	ELLIOTT, W. E.	Air Force - WPAFB	8870
	ESCARENO, Elias A.	Fort McClellan, Alabama	16120
	JOHNSON, Samuel	Fort McClellan, Alabama	7805
	KNEPSHIELD, C. E.	Air Force - WPAFB	5700
1953	LEE, Richard H.	NMRI	6480
	MARKOW, Basil	ESL	16100
	MAYER, William E.	1090th RPTG SP/GP	5155
	NORRIS, James C.	Naval ordnance. (TS Inyokern)	7670
	PARNHAM, Arthur L.	U. S. Navy	5863
	PARRA, Robert L.	Fort McClellan, Alabama	8420
	RICHARDSON, George W.	Fort McClellan, Alabama	7690
	RUTLEDGE, Ira W.	Desert Rock.	7120
	SCHANKEL, R. M.	Air Force WPAFB	5100
	SHARP, Robert	NMRI	6145
	SQUILLANTE, Thomas	ESL	16890
	SWAIN, Kenneth E.	Lowrey AFB	6860

INDIVIDUALS EXCEEDING 5 rem (cont'd)

	NAME	ORGANIZATION	mrem
1953	TALMADGE, Walter	Fort McClellan, Alabama	5645
	THOMPSON, P. E.	U. S. Navy	8850
	TYPANSKI, Leonard J.	Fort McClellan, Alabama	5495
	WEBER, Robert N.	Fort McClellan, Alabama	5345
	WHITAKER, J. K.	Air Force - WP AFB	6860
	WHITTEN, Frank I.	DWET	7845
	WILLIAMS, Raymond E.	Lowrey AFB	5490
	WILSON, John D.	Fort McClellan, Alabama	5260
	ZAHMT, Kenton, W.	Wright Field	7400
1955	CLAYTON, D. W. 2nd.Lt.	347th TCRCHARW, Stewart AFB	6470
	EDGAR, John S/Sgt.	3083rd ADG, Fairfield AFB	5070
	GASE, Frank R. Capt.	345 TP Carrier SQ, Stewart AFB	5230
	GRANT, Paul PFC	CMLC CML & Rad Labs. ACC, Maryland	8440
	NELSON, Ronald G., Pvt.	2nd CML WPNS BN, DPG, Tooela, Utah	7060
	OLDFIELD, C. S., Capt.	AFSWC RES DIR KAFB, N. M.	12285*
	PAGE, M. M. Jr., M/Sgt.	1st RSSU	16000
	PATTERSON, F. H., Lt.	4926th TST GP S KAFB	10560*
	PINSON, Ernest A., Col.	SWS KAFB, N. M.	21825*
	PURCELL, B. H., Capt.	1st RSSU, Chief, Dosimetry & Records	19300
	ROBBINS, John R., 1st.Lt.	346th TCRONARW, Stewart AFB	6155
	RUPP, F. D., 2nd Lt.	345th TCRONARW, Stewart AFB	5260
	WILLIAMS, Joseph	Detroit Arsenal, Criterline, Mich.	5750

*Over exposure authorized by Test Manager or Test Director in advance.

1957	ALDER, John J.	KAFB	6485
	BOUNDS, Malcolm S.	KAFB	6120
	BUSH, Firzhugh G., Jr.	KAFB	5325
	HALL, Richard E.	KAFB	5015
	HERRY, Cale C.	KAFB	6365
	KELLEY, Robert L.	KAFB	6120
	KRULL, Wilfred L.	KAFB	5120
	MIEARS, Roy R.	KAFB	5610
	MONTUNNAS, Stanley	KAFB	9945
	SCOTT, John E.	KAFB	6785
	WRIGHT, William N.	KAFB	6385
	WYNN, James H.	KAFB	10105

INDIVIDUALS EXCEEDING 5 rem FOR 1957

DESERT ROCK VII & VIII 1957

(Source; Microfilm from Lexington Army Depot)

NAME	RANK/SERVICE NUMBER	ORGANIZATION	DOSE
PRIDEMORE, Billy	Sgt., NG 12333135	Batry. B, 617th FA	6.40 rem
RUSSELL, Joe L.	Pfc. US 54188510	Btry. A, 529th FA	6.00 rem
BURGER, Harold D.	Spec.3, RH-16517165	495th Miss Bt. Ft. Bliss, Texas	10.00 rem
GILLARD, Eddie J.	167	312th Fight. Bomb Wing	6.28 rem
HARVEY, William	E-2, US-56282156		5.65 rem
GOODWIN, George S.	Spec.3, RA-19520124	90th Repl.Det. Ft. Lewis, WN	5.75
RODRIQUEZ, Fred Jr.	E-2, US-28130886	50th Cml. Platoon (SVC) Ft. Ord, CA	58.0 rem*
PEARCE, Garry M.	Captain, 053034	Hq. 4th MCPAEB Desert Rock, NV	7.2 rem
WESTRICH, Ralph L.	Captain 064661	285th FA Obsr. Bt. Ft. Bragg, N.C.	5.1 rem
SEARS, Don B.	Pvt. 2 RA-15566616	293rd Military Police Co., Camp Desert Rock, NV	7.0 rem
WHADEN, Leo B.	Pvt. 2 RA-12502668	293rd Military Police Co., Camp Desert Rock, NV	7.0 rem

*Records indicate this badge was misplaced and later found by a ^{60}Co source.

AGENCIES AND PERSONS CONTACTED

AGENCY	INDIVIDUAL	REMARKS
AEC/NV Consultant	Dr. Clinton S. Maupin	No knowledge of dosimetry procedures.
6th Army HQ	Lt. Col. Huot	Directed us to several retired officers whom were unable to give any useful information. Col. Huot did not find any records of interest.
Chemical Core School Fort McClellan, Ala.	Col. Powell	Dosimetry Records at Fort McClellan contain only exposures received by personnel during training at the school.
Edgewood Arsenal	Mr. Earl Wright	Gave directions to the Lexington Depot.
Evans Signal Lab. Ft. Monmouth, N.J.	Capt. Walden	Looked for the 232nd Signal Company and found they were believed to be in Vietnam. Col. R. Ray's office contacted and they have asked the to try to locate the 232nd records.
Los Alamos Scientific Laboratory, Mercury, Nevada	Col. Gordon Jacks (retired)	Provided contacts at Edgewood and Lexington.
Lexington Signal Depot Lexington, Kentucky	Mr. Ed Adney Mr. Joseph King	Provided the 1957 Dosimetr (400 ft. of 16 mm microfil Had no knowledge of efforts in dosimetry by other Sign Corps organizations.
Sacramento Army Depot Sacramento. California	Mr. Burt Anderson	Sacramento only has records since the beginning of its existence in 1958.
Sandia Base Albuquerque, N. M.	Col. Service	Directed us to Col. Ed Fountain, he knew of no storage locations of Recor other than Mercury, Nevada and Lexington, Kentucky.

AGENCY	INDIVIDUAL	REMARKS
Walter Reid Army Hospital Washington, D. C.	Maj. Kendall's office, Health Physics officer	Was unable to locate any records of interest.
—	Col. Ed Fountain	Gave directions to the Army Lexington Depot
Hospital, Sandia Base	Col. Fitzpatrick	——
DASA, Sandia Base	Col. Gray	——

Mr. **Walgren**. No follow up whatsoever that we know of until you come along in 1977 and find the 10 people. The record is silent between the conclusion of the tests and your looking at the record in 1977.

Dr. **McIndoe**. Mr. Walgren, the dose recorded only exceeded the quarterly allotment for those individuals, it did not exceed the accepted annual dose. And, considering that these men were only there for that one series or event, and were not in a radiation industry or radiation-related occupation, there would be no reason to followup further, unless they exceeded the radiation dose for that year. Each branch of the service has its radiation followup regulations, which are guided by the dose received. At the dosage level Major Skerker is referring to, the thing which would have been accomplished at that time would have been a simple blood count; if there was a question of internal emitters, that a urinalysis would have been accomplished. But if the total dosage did not exceed that allotment for 1 year, there would have been no reason to followup after that.

Mr. **Walgren**. Even though it exceeded the quarterly dosage?

Dr. **McIndoe**. That is a very common thing in the radiation industry that a man may receive up to his quarterly allotment and then drop out for a given number of weeks, until he is back in the line again.

Mr. **Walgren**. But in these cases they received more than a quarterly allotment.

Dr. **McIndoe**. Yes; and as I recall, they were checked, as he just said. But if they did not exceed it for the year there would be no reason to followup on it the year after.

Mr. **Walgren**. I see. So the Department of Defense takes the position that even though somebody received a short-term overexposure, there was no reason to follow along thereafter.

Dr. **McIndoe**. That is correct, other than the fact that it is in their record.

Mr. **Walgren**. And now the computer printout that you are familiar with, showing a high dose of 998——

Dr. **McIndoe**. I would like to correct the record on that, sir, it was 9,800, which would have been 9 rem.

Mr. **Walgren**. 9,800, which would be 9 rem.

Dr. **McIndoe**. Almost 10 rem.

Mr. **Walgren**. Ten rem. Now, what is the relationship—excuse me for unknowing—between a rem and a rad?

Dr. **McIndoe**. One is the radiation absorbed dose, the other one is radiation equivalent, mammal; and for practical purposes, on most occasions, they are equal.

Mr. **Rogers**. Dr. Carter?

Mr. **Carter**. A rem is the amount of radiation received from one roentgen of X-rays; is it not?

Dr. **McIndoe**. Again, that would be a reasonable approximation, sir.

Mr. **Carter**. Thank you.

Mr. **Rogers**. Let me just ask a few questions. From your testimony, Major Skerker—and we will go over it in detail—it would appear that Smoky may have been one of the best controlled of the studies; would you agree with that?

Major **Skerker**. Well, Smoky probably had more freedom of movement than most other tests.

Mr. **Rogers**. Well, what about Nancy?

Major **Skerker**. It probably had more freedom of movement, but the freedom of movement was probably in a lower radiation area.

Mr. **Rogers**. So, we may have picked out by chance one that is not as bad as some of the others to look at, and investigate.

Major **Skerker**. That possibility exists, and that is precisely why I felt it was necessary to outline what other tests of significance there may have been.

Mr. **Rogers**. That is really something. Tell us about Nancy, that may even be worse than this rather rough experience with Smoky. Would you read that to us? That is on page 11 of your statement, I believe, Major.

Major **Skerker**. On March 24, 1953, the Nancy event, a 24, kt device was detonated from a 300-foot tower. Participation in this event was 2,838 military and 16 civilians.

Mr. **Rogers**. So, almost as many people participated in this Nancy event as in Smoky; is that correct?

Major **Skerker**. Yes, sir; there may actually be more.

On March 22, 1953, the observer group had entered the Annie equipment display area. The levels of residual activity have not yet been identified. For the Nancy shot, observer trenches were located at 4,000 yards. The wind shift blew the radioactive cloud over the trenches where the dose due to cloud passage is reported to be 18 mrem. The provisional batallion combat team launched their attack 3 minutes after the explosion and moved to between 500 and 700 yards of ground zero. There was heavy fallout in the maneuver area, an intensity of 14 r/hr at some unknown point was reported. The CBR monitors proceeded into the contaminated area without giving any indication of their readings to their commanders. Upon the direction of the rad-safe officer, units were withdrawn but the unit commanders experienced difficulty in withdrawing their forces.

Mr. **Rogers**. And the next paragraph, I think would be helpful.

Major **Skerker**. Film badges were not issued to each man. The allocation of badges was one per platoon and one per observer bus load. This was done because the film dosimetry section could not keep up with the workload.

Mr. **Rogers**. And the next paragraph?

Major **Skerker**. The Nancy shot should receive a priority effort in the followup program. The identification of participants will be particularly difficult since they came from units in the 2d, 3d, 5th, and 6th Armies.

Mr. ROGERS. So, these men may have been subjected to much more radiation than those involved in Smoky.

Major SKERKER. Potentially. The intensities were very great, but of course we do not know for how long they were exposed to these intensities.

Mr. ROGERS. Do you know which men were exposed? You only gave one badge out there; did you not?

Major SKERKER. Yes, sir.

Mr. ROGERS. For a whole platoon.

Major SKERKER. What we have identified are the posts in the United States from which the people were drawn. Now, the next step is finding in the historical files all the units at that post, and then ultimately——

Mr. ROGERS. Well, I thought that was under your command at, what is it, Desert Rock? You told me you had all these records from Desert Rock.

Major SKERKER. Yes, sir. But in this text, when I explain the 53 series, I indicate that the people, unlike in other years when they were drawn from organized units, in 1953 they were drawn from a variety of posts, small groups; sent for temporary duty to Camp Desert Rock, formed into provisional battalion combat teams, and given the training.

That basically means, since the records reside with the man's home unit, that we have to identify what home units are involved before we can find out what people were in those home units.

Mr. ROGERS. In other words, Desert Rock did not keep the records of the individuals involved in testing, as to their reaction to radiation and so forth?

Major SKERKER. Well, sir, right now I have not identified any central repository for 1953 records.

Mr. ROGERS. And I would think for one man to find all those records would be an impossible job; don't you, Mr. Haas?

Mr. HAAS. I would agree to that.

Mr. ROGERS. Could you change that situation, is that within your authority?

Mr. HAAS. Well, I think, Mr. Chairman, it will shortly be under our authority. I fully agree that a crash program is indicated. The point is, I believe, as Major Skerker has pointed out, that as time grows older and older, that is to say, as the tests conducted were more and more in the past, starting in the early 1950's, it is fully admitted that the control was less and less; and the film badging was less and less thorough.

You are quite correct, Mr. Chairman, in pointing out that the 1957 Smoky was probably one of the much better controlled events.

Mr. ROGERS. So, many people may have really had excessive exposure in other shots, and have never been notified.

Mr. HAAS. That is quite possible, Mr. Chairman.

Mr. ROGERS. Now, you say a crash program is indicated. Was that not indicated to you last year in February, when you were contacted by the CDC, bringing up this entire problem to you?

Mr. HAAS. At the request of the CDC—Dr. Caldwell—we first concentrated all our efforts, sir, on Shot Smoky.

Mr. **Rogers**. You had knowledge, did you not, of those other shots, and the fact that Smoky may have been by far the best controlled?

Mr. **Haas**. Well, as I pointed out earlier, Mr. Chairman, these records go back 20 years, and it is quite true that neither the Department of Energy nor the Department of Defense has paid much attention to those shots for the last 20 years until Dr. Caldwell called attention last February to this possible leukemia situation.

I believe we have made quite an impact on Dr. Caldwell's study since then and are proceeding as rapidly as we have been able to. As Major Skerker pointed out, we have accumulated a record, after all, of close to 20,000 identifications.

Mr. **Rogers**. Now, let me ask you, CDC, they told us, asked for the records from Smoky, and they were told—I think, Colonel, by your organization—that they would have to give you the individual name. Is that true?

Dr. **McIndoe**. In order to look on our list to cross-reference the name with the individuals requested by Dr. Caldwell we needed a name, a serial number, or a social security number, a time, the event, et cetera, pieces of information so that we could go to our list and see if that name indeed existed on that list.

As Major Skerker has pointed out, there were names from provisional units which were records kept in Lexington, which were not in a central repository. We offered to Dr. Caldwell our resources as available at that time, that we would make all the searches; that he would supply us with identifying numbers.

Mr. **Rogers**. Now, how could CDC find out the names of men in the units? That is under control of the records of the Department of Defense. How did you expect him to do that, with a magic wand?

Dr. **McIndoe**. In the statement I said, sir, it was at the time Dr. Caldwell was requesting an index case. And then the second case, I believe, was Mr. Coe; and that was the time when the Surgeon General was brought in and the problem was recognized that if we were going to have to get this information, it had to be an effort requiring more than the resources of the Medical Corps. This is when we went to the Department of the Army and Major Skerker was brought in to get us that information.

Mr. **Rogers**. How many men do you have on this, working full time?

Dr. **McIndoe**. At the present time I have the responsibility divided up among four people, and I would say they are probably devoting from a quarter to half of their time to it, since the beginning of December.

Mr. **Rogers**. Maybe one full man.

Dr. **McIndoe**. The effort, as it was to be inaugurated, once the NRC was to develop the protocol and we were to interface, I had provisionally supplied four personnel to handle this problem. And we had requested Major Skerker's transfer to our organization.

Mr. **Rogers**. And the Major is now transferred to you?

Dr. **McIndoe**. He is not, sir; we have an official request in.

Mr. **Rogers**. Let us have for the record exactly who is working on it; what period of time they have been working, and that they are devoting their time, please.

[The following information was received for the record:]

As of February 12, the Defense Nuclear Agency had 35 individuals working full-time on direction of the overall program. A copy of names, positions, and telephone numbers is attached. These assignments will change as the needs of the program change.

The four services will each operate a separate research effort to develop data on military and civilian units and personnel (including contractors) for whom responsible. These efforts are just now getting underway and will expand rapidly. Current details are:

Army. The principal point of contact is Colonel Victor Hugo, office of the Chief of Staff. The Army currently has 4 officers and 31 others whose principal assignment is this program.

Navy. The principal point of contact is CDR Milton Finkelstein. The Navy currently has 6 officers and 20 others whose principal assignment is this program.

Marine Corps. The principal point of contact is MAJ Rafael Negron. The Marine Corps also has 2 officers and 3 other personnel whose principal assignment is this program.

Air Force. The principal point of contact is Lt Col George Kush. The Air Force has 2 additional officers and 7 other personnel whose principal assignment is this program.

PERSONNEL ROSTER
ATMOSPHERIC NUCLEAR TEST REVIEW

ORGANIZATION	NAME	POSITION	PHONE
AFRRI	Dr Paul Tyler	Program Manager	295-1211
AFRRI	LTC John Mason	Assistant Program Manager	295-0586
AFRRI	CAPT Edward Mateik	Telephone Response Quality Control Manager	295-1426
AFRRI	HMCS James Plummer	Assistant Telephone Response Quality Control Manager	295-1426
AFRRI	Ms Patricia Ryan	Secretary	295-1211
AFRRI	Ms Elizabeth Linkins	Secretary	295-1316
DNA	LTC Hartman B Mowery	Hq DNA Project Officer	325-7124
DNA Controller	Mr John Long	Computer Program Manager	325-7118
DNA Controller	Mr Thomas Wotring	Computer Operator	325-7147
FCDNA, Kirtland AFB, N.M.	Mr William Eisengard	Research Director, AFSWP Records	505-264-2212
DNA Contract, DASIAC, Wash, D.C.	Mr William Alfont	Staff Researcher	325-7358
DNA Contract, DASIAC, Santa Barbara, CA.	Mr Warren Chan	Research Director	805-965-0551
	Mr Edward Martin	Document Research Coordinator	805-965-0551
	Mr Michael Durlash	Staff Researcher	805-965-0551
	Ms Evelyn McDonald	Staff Researcher	805-965-0551
	Dr Judy Rosenfield	Staff Researcher	805-965-0551
	Dr Howard Hawthorn	Staff Researcher	805-965-0551
	Mr Charles Anderson	Staff Researcher	805-965-0551
DNA Contract, DASIAC, Albuquerque, N.M.	Dr Lynn Kennedy	Staff Researcher	505-266-8757
	Mr Gerald Perry	Staff Researcher	505-266-8757
DNA Contract, Systematic Coorp, Springfield, VA.	Mr William Gillam	Key Punch Operator	703-550-7368
	Ms Linda Jacobs	Key Punch Operator	703-550-7368
	Ms Elaine Brewer	Key Punch Operator	703-550-7368
	Ms Arlene Denton	Key Punch Operator	703-550-7368
	Ms Mary Thorpe	Key Punch Operator	703-550-7368
AFRRI	Ten (10) personnel selected each day from duty roster	Telephone Operators	800-638-8300

Enclosure 1

Mr. **Rogers**. Also, what about Hood, July 5, 1957; are you aware of that?

Major **Skerker**. Yes, sir; that was a Marine Corps shot.

Mr. **Rogers**. I understand that was a 77 kt blast.

Major **Skerker**. That is right, sir.

Mr. **Rogers**. What was the exposure there?

Major **Skerker**. I do not know what the exposure was. I have been assuming that the other members of the ad hoc committee have also been looking into other aspects of the test program. We do have a member from the Marine Corps.

Mr. **Rogers**. Who else is looking into it now?

Mr. **Haas**. We will have to provide that information for the record, Mr. Chairman.

[The following information was received for the record:]

The information requested is being compiled at the present time. A review of all applicable records, rosters, and films is underway. The information will be provided to the subcommittee when it is available.

Mr. **Rogers**. You do not have anybody checking that, yet.

Mr. **Haas**. The Marine Corps has apparently commenced an effort, I have Colonel Dunwell from the U.S. Marine Corps here in the audience for the particular purpose of attending this hearing. He is not familiar with what has been done, although he was a participant in the tests the year before that. We will have to provide that information for the record when it becomes available, sir.

Mr. **Rogers**. Now, the staff has discussed with your people that we wanted to get into Hood, and you are not able to?

Mr. **Haas**. We are not prepared, sir, to have that information available today.

Mr. **Rogers**. Well, will you have it tomorrow?

Mr. **Haas**. I do not know, sir. I have requested the Department of the Navy to provide that information on participants as early as possible.

Mr. **Rogers**. Well, now; who in the Navy is not responding? We contacted you some time ago on Hood. Do we have to call the Secretary over and ask him to do it for us?

Mr. **Haas**. I do not believe so, Mr. Chairman.

Mr. **Rogers**. Well, we will do it if we have to get to it, to that extent. But now, the Congress is trying to look into this. We do not have a lot of time. We know you are busy and we hate to interrupt your schedules. But we cannot expect to continue holding hearings and accomplish anything if witnesses are not going to bring information that we have asked for.

Now, the staff discussed Hood specifically with your people, Mr. Haas. I hope we do not have to go in to subpenas in getting a whole inquiry bit going on this.

Mr. **Haas**. Certainly not, Mr. Chairman. But staff's request to us for shot Hood is only of the order of two weeks ago, and we had only that time to get the Department of the Navy to see whether or not they have research on it.

Mr. **Rogers**. Who is it you contacted in the Department of the Navy?

Mr. **Haas**. I will let you know that, sir.

[The information requested was not supplied by the Department at the time of printing.]

Mr. ROGERS. Do any of your staff people here know whom you contacted?

Mr. HAAS. I personally talked to Vice Admiral Arenson, the Surgeon General of the Navy.

Mr. ROGERS. The Surgeon General. I want the staff to contact the Surgeon General to let us specifically know when they have that information available; if not, I want the Surgeon General here to give us that information. We have to begin to look at these things. That was 77 kilotons. That is almost double what Smoky was. So, no telling what has happened there. And did not the marines there move within 400 yards of ground zero minutes after the blast? Can anyone tell us, Major?

Major SKERKER. Yes, sir. I could read into the record the section on the marine brigade exercise for Diablo Hood. Shot Diablo Hood, June 26, to July 5. The purpose was to provide realistic training, particularly for command and staff personnel in all phases of planning and conducting of operations supported by atomic fires. To test and evaluate doctrine, develop new tactics and techniques relative to the exploitation of atomic fires, and to familiarize personnel with the effects of and passive defense measures against atomic weapons.

Concept and conduct of the test. The field exercise was scheduled in conjunction with Shot Diablo, which misfired on June 28; it was adapted on short notice to Shot Hood and detonated at 0440, July 5, 1957. As planned, the ground operations commenced at mike hour H plus 15 minutes. The tactical maneuver involved a helicopter lifting of elements of a batallion attacking to seize an objective which, for safety reasons, was some distance removed from ground zero.

MAG-15 provided 24 jet aircraft as tactical air support. Helicopters used to conduct the troop lift were initially positioned at minimum safe distance from ground zero. As soon as the large cloud of dust cleared at 8 plus 85 minutes, they made the initial lift from this position. All subsequent lifts were made from the troop loading zone in the vicinity of the Hood trenches, where all the ground troops observed the shot.

After the explosion one company moved to within safe distance, 400 yards, of ground zero and later returned to the helicopter loading zone behind the trench ara to await helicopter lift to landing zones. One company moved directly from trenches to loading zone for helicopter lift, and one company of the batallion moved from the trenches, mounted LVTP-5's, and supported by a platoon of ONTOS attacked toward the ground objectives, where they linked with the helicopter-borne force at 050900 Tango July.

Mr. ROGERS. I have that in your statement here.

Let me ask you this, in Hood, did not Desert Rock do the dosimetry?

Major SKERKER. Yes, sir.

Mr. ROGERS. So, they should have all the records there at your command.

Major SKERKER. I believe I do, sir; I do have some Marine Corps records.

Mr. ROGERS. Then, why do you need it from the Navy, Mr. Haas? Why do you have to go to the Navy to get the records, if you have them?

Mr. HAAS. The records of the personnel was what I was referring to, Mr. Chairman. I believe the dosimetry records were taken care of by the Army under Project Desert Rock.

Mr. ROGERS. But you do not know whether each man was given a film badge.

Mr. HAAS. We were not given that information, nor do we necessarily have the names on the dosimetry, whether they were Marines, each and every one of them, I believe.

Mr. ROGERS. What about that, Major?

Major SKERKER. Well, basically, from an operational standpoint I would like the Marines to be able to explain the Marine Corps operation.

Mr. ROGERS. Well, I am just trying to learn of the Army's. I have not even approached the Marines yet. We are just saying, if you kept the records, do you not know who was involved in it? Instead of going through it service by service and let each one come in and insert an independent statement, I thought you told us before that all of the records of ground troops—be they Marine or what—you kept the records.

Major SKERKER. I have the Lexington records, and on those Lexington records I can identify some marine troops that are from the 4th Marine Corps Provisional Atomic Energy Brigade. I do not know if they are all the Marine Corps personnel involved.

Mr. ROGERS. But there was this heavy exposure in Hood.

Major SKERKER. Yes, sir.

Mr. ROGERS. And they have not been notified.

Major SKERKER. That is right.

Mr. ROGERS. But you have their records, and you know who they were, of those exposed.

Major SKERKER. I have the records, I cannot very readily tell you who they were because it takes a while to go from the microfilm to some other reasonable——

Mr. ROGERS. Well, I understand, only one man there, you could not reasonably do it in 1 week.

Mr. CARTER. Mr. Chairman?

Mr. ROGERS. Yes, Dr. Carter.

Mr. CARTER. I just want to state that it seems to me that in tracing records we have confusion here compounded and compounded. And really, it would be easier for us to find the members of Quantrill's guerrillas than it would the men who were at Desert Rock or one of these other places. I have never seen such confusion in all my life. I think if you have no more organization and no more knowledge of what you are doing, then a dozen good men with some willow switches could whip the Pentagon. I have no confidence in your recordkeeping whatever after hearing this testimony. Thank you, sir.

Mr. ROGERS. Let me ask you this, Major; you state no available rate meter meets military specifications and measures beta radiation satisfactorily.

Major SKERKER. That was from Operation Teapot, if I am correct.

Mr. ROGERS. I think it is in your written statement.

Major SKERKER. Right. There is more to the quote there, and I would like to turn to it, if I may.

Mr. ROGERS. What page is that on?

Well, while you are looking for that, let me ask this: the Apple II shot, May 5, 1955, 29 kt, the recorded overexposures between 3 and 6 rem for 97 persons; between 6 and 20, 15 persons; and over 20, 2. But individuals are not yet identified, as we understand from page 14?

Major SKERKER. That is correct, sir. Those are the numbers reported in the operations report, and they are just numbers of people with those exposures. We have no knowledge of names.

Mr. ROGERS. And so, we do not know what has happened to them.

Major SKERKER. No, sir.

Mr. ROGERS. It is page 16 of your statement.

Mr. WALGREN. Mr. Chairman, if I might suggest, I am wondering whether the national news media might be able to help us out, if the commentator were to add a tag that the Defense Department apparently has lost track of these people and the Congress would very much like to hear from them; that if anybody with any knowledge of an exposure of a soldier or civilian through this kind of testing were to drop us a note my guess is that the random sample would be very statistically valid, and we might be able to see very directly what the cause and effects of these tests were.

Mr. ROGERS. The committee will pursue that; I think that is a good suggestion.

I believe on page 16 of your statement.

Major SKERKER. I believe we are referring to the evalution of military radiac equipment.

Mr. ROGERS. Excuse me?

Major SKERKER. Where it says project 6.1.1a, "Evaluation of Military Radiac Equipment":

> Satisfactory tactical dosimeters and rate meters are now available for measuring gamma radiation. The IM-93, and the IM-108 (XE-2)/PD. However, beta and neutron radiations can also have very important biological effects. The importance of these effects from nuclear detonations is becoming more and more recognized.
>
> The beta radiation problem is mainly a problem of rate meters, since there is little significant flash beta radiation from nuclear detonations, and since the problem is mainly one of determining whether a contaminated area is safe to remain in or enter. No available rate meter meets military specifications and measures beta radiation satisfactorily. Casualties could easily result from beta burns received in a contaminated area indicated safe by gamma instruments of the AN/PDR-39 or IM-108 type.

It should be noted that the range of the IM-108 is 1 to 500 r/hr and the AN/PDR-39 is essentially the AN/PDR-T1B which are both higher range instruments.

Mr. ROGERS. So, you are talking about measuring one but not the other, the beta.

Major SKERKER. Yes, sir. What it is really saying there is that the beta ray, when you get into the higher gamma fields, can be very significant.

Mr. ROGERS. Well, if that is true, how do you know what total radiation level was present in various distances and times from the shot, if you could not properly measure them?

Major SKERKER. I presume the assumption was made that if you avoid the high areas of gamma activity, you will have avoided, relatively speaking, the areas of higher other contaminants.

Mr. ROGERS. That is not the question I asked. I asked, how do you measure beta, and to tell whether they really got beta rays, or not, at those high levels.

Major SKERKER. Well, you can measure beta also with an ion chamber. It is an ionizing radiation, the only thing is, you need a window that will not stop it.

Mr. ROGERS. Well, you just said no available rate meter meets military specifications and measures beta radiation satisfactorily. That is your statement, not mine.

Major SKERKER. That is right. I am saying, at that time there was no instantaneous way of measuring beta in the field.

Mr. ROGERS. And is not the fallout heavy in beta?

Major SKERKER. Yes.

Mr. ROGERS. So, you did not measure it.

How about the contours on the map entitled, "Oak Spring Quadrangle"? I think you are familiar with it.

Major SKERKER. Right, sir.

Mr. ROGERS. What do those represent, beta, or gamma, or what?

Major SKERKER. Those are gamma, total dose.

Mr. ROGERS. There is no way to tell what the beta was from that.

Major SKERKER. That is right.

Mr. ROGERS. Now, I see we are having a vote, and the committee will stand in recess for 10 minutes.

[Brief recess.]

Mr. ROGERS. The subcommittee will come to order, please.

I might say because of time I think tomorrow we will take the Department of Energy and the VA, so we will not hold you any longer. I apologize to those witnesses who were here. We will not take you until tomorrow at 10 o'clock; and if possible Mr. Coe, we will see if he can arrange to be here tomorrow, too. So, we will try this afternoon to finish with the Department of Defense, for this first session in any event.

I was talking about the difficulty in measuring the beta radiation. I notice that the Army's final report on operations at Desert Rock in 1957 referred to radiation dosimeters not accurately measuring radiation because the dose was higher than the range measured by the dosimeter.

> The radiation dosimeters, while chosen according to TM23200 were of too low a range for the radiation they actually received. Laboratory analysis of the dosimeters will be required before the radiation results are known.

Now, these dosimeters were placed in foxholes 1,000 yards from ground zero and covered with tanks and armored personnel carriers to block the radiation.

Now, were the same dosimeters used by troops involved in nuclear tests?

Major SKERKER. I have not been able to identify what dosimeters they are talking about, that were placed in these tests.

Mr. ROGERS. Well, the Training Manual 23200, I presume, would describe it. It says, "chosen according to the training manual."

Major SKERKER. It would describe all the dosimeters available, which still leaves the question open.

Mr. ROGERS. How many are described in TM23200?

Major SKERKER. Let me provide that for the record, sir.

Mr. ROGERS. Well, about how many would you think?

Major SKERKER. In 1957?

Mr. ROGERS. Yes.

Major SKERKER. I really do not know, sir.

Mr. ROGERS. All right, I will not press that. If you would supply that for the record.

Major SKERKER. Yes, sir.

[The following information was received for the record:]

TM 23-200, "Capabilities of Nuclear Weapons", is a classifiied document currently in use. It contains charts, tables, and nomographs that describe the effects of nuclear weapons. There is no dosimeter information contained in the document. If the committee wishes to review the document it will be provided. However, it cannot be declassified.

Mr. ROGERS. Now, is it not possible that the soldiers with these dosimeters—if what they say is true in this report—received a higher radiation dose than was recognized and recorded by those who actually processed the dosimeters?

Major SKERKER. If we are talking about the film dosimeters, to the best of my knowledge, this was the DuPont 553, which is a three-segment film. And in terms of solarization that probably would not occur until around 250 rem, which is an extremely high dose.

Mr. ROGERS. Well, now, the final report said they were of too low a range for the radiation they actually received. Are you telling me, then——

Major SKERKER. The equipment displays, though, that I think they are referring to, are the ones going south of ground zero, go through some extremely high exposures, even at 1 hour after the detonation. So, it is quite conceivable that the exposures were well up over the 250 rem in those equipment areas for the period of exposure.

Mr. ROGERS. So, they actually could have gotten more then, more exposure. More than the badge even would show.

Major SKERKER. If that particular badge was placed close enough to ground zero, certainly.

Mr. ROGERS. So, it could have been a higher dose of radiation that would have been recorded, it would have been possible to record.

Major SKERKER. In the equipment displays, yes, sir. But at those exosures, sir, if a man was there—in other words, what I am saying, if a man was exposed to 250 rem whole body, you would have seen a lot of early casualaties.

Mr. ROGERS. Well, how many have you had die of the overexposed that you found?

Major SKERKER. By "early casualties" I mean within a 30-day period of the detonation. There is nothing like that known.

Mr. ROGERS. Can you explain the differences between the AEC radiation exposure standards and the Department of Defense radiation exposure standards in use at the Nevada Test Site in 1957, and why did the different exist?

Dr. MCINDOE. I can attempt to answer that, sir. At the time the tests were run the amount permissible could be exceeded under given circumstances under the direction of the Test Director if it was felt that, again within the limitations of the annual dose limit that the safe level for the year would not be exceeded.

Now again, you have the radiation worker's maximum amount and the public's maximum amount allowable. So, there is basically a civilian, an industrial, and a military situation for radiation exposures.

Mr. ROGERS. And what were the differences between the Atomic Energy Commission's standard at that time, and the one used by the Army?

Dr. McINDOE. In reviewing the records from that time, as I recall, 3 rem per quarter maximum was increased to the 5 rem per quarter for the test series. And the shot was considered as a quarter. You could not exceed 5 rem for more than six months. It would be the type of thing that if you were in a shot and recieved 5 rem, you could not be around a radiation area again for at least another 6 months.

Mr. ROGERS. Yes. Now what was the AEC's at that time?

Dr. McINDOE. I do not actually recall, sir; I would have to get back into the standards at that time. As I recall it was 3 rem per quarter, and 5 R per year.

Mr. ROGERS. Major, do you know?

Major SKERKER. It was during 1957 that the change occured, and I just do not recall if it was before or after Smoky that they changed from 3 rem per quarter to the 5 rem per year.

Dr. McINDOE. The noncombat exposure rate for the Army came into effect in November 1957, which reduced it from 15 to 5 rem per year, and the 3 rem per quarter; and I believe a max of 0.3 rem per week.

Mr. ROGERS. And why, then, did the Army set a higher standard for the year than the AEC?

Dr. McINDOE. They did not, sir. The dose at that time, I believe, married up, in November 1957, which would have been at the completion of the Plumbbob series.

Mr. ROGERS. Well, it is not my understanding that during Plumbbob your standards were identical to the AEC. Is that what you are telling me?

Dr. McINDOE. I am saying that the maximum allowed for exposure was 5 rem.

Mr. ROGERS. Per what?

Dr. McINDOE. Per quarter.

Mr. ROGERS. Which is far above what the AEC had at that time.

Dr. McINDOE. I do not recall their specific number, but as I recall it was 3.

Mr. ROGERS. I think you said it was 3 a quarter, and 5 a year. but you were giving it 5 per quarter. Now, why was that done, do we know?

Dr. McINDOE. I cannot answer that question, sir.

Mr. ROGERS. Now, what are your current standards?

Dr. McINDOE. Five rem per year, sir.

Mr. ROGERS. Five rem per year. And you made that change in November 1957; is that what you said, Major?

Dr. McINDOE. I said it.

Mr. ROGERS. You said it. and it has been the same since 1957.

Dr. McIndoe. Yes, sir.

Mr. Rogers. Have you done any experiments, any work that would indicate that is too high a level?

Dr. McIndoe. No, sir; I do not recall having read any work where it was suggested that was too high.

Mr. Rogers. Do you believe that radiation is cumulative in its effect on humans?

Dr. McIndoe. If you ask me if I believe in the threshold of the linear series, sir, I have no feelings, one way or the other. I try to keep my exposure as low as possible.

Mr. Rogers. Well, that does not help me much. The committee is trying to make judgments.

Mr. Carter. Mr. Chairman?

Mr. Rogers. Go ahead, Dr. Carter.

Mr. Carter. I have a comment on that point. If you have a limit of 0.3 rem per week and 0.5 rem per quarter, and a yearly limit, then it seems to me that you must realize there is a cumulative effect, or you would not have a total limit for the end of the year.

Dr. McIndoe. It would appear from the data that the more radiation you accumulate the higher the incidence of radiation effects become as time passes.

Mr. Carter. In other words, it is cumulative.

Dr. McIndoe. Yes, sir.

Mr. Carter. All right, that answers the Chairman's question.

Mr. Rogers. I thank the gentleman. So, if it is cumulative we have to really look at the standards set, and on low-level radiation; would we not?

Dr. McIndoe. I think if there is an indication that the level of safety which has existed for the last 20 years is not low enough, then I certainly stand ready and try to put it in a range where it would be acceptable.

Mr. Rogers. Some of the scientists have testified to that yesterday and they believe, at least Dr. Morgan stated he felt very definitely it was cumulative and our standards are too high.

Mr. Carter. in case of inhalation and ingestion, Mr. Chairman, we also have the problem that internal emitters remain in the body and the half-life of such radioactive particles in some cases is 200 years.

Dr. McIndoe. The internal dosage is a very difficult problem.

Mr. Rogers. So, this would mean that low level radiation, then, could be cumulative and have very adverse effects; is that true?

Dr. McIndoe. I cannot deny that it may not be true, no, sir, I cannot say that.

Mr. Rogers. But can it be true?

Dr. McIndoe. I have not seen the data that would make me feel that it is likely to be true. I try to keep an open mind about it.

Mr. Rogers. In other words, you do not think it matters how many X-rays doses you get, if it is in small amounts?

Dr. McIndoe. Again, sir, I feel for the benefit of any individual involved that we keep their radiation exposure to a minimum.

Mr. Rogers. I know, but what we are saying, we have to decide whether our standards are right or not. Now, it is not very helpful for us to come out and say, well, let's everybody keep it as low as we can.

Dr. McIndoe. We have a standard, sir.

Mr. Rogers. We have a standard and you told me it is too high.

Dr. McIndoe. No, I did not say it was too high. I said I have not yet seen any data that would suggest that it is not safe.

Mr. Rogers. Well, I'm sorry I misunderstood.

Dr. McIndoe. I am sorry if I implied that, sir.

Mr. Rogers. Well, you think the standards are OK, then?

Dr. McIndoe. I have not seen anything in the last 20 years since the standard was established to make me think differently.

Mr. Rogers. In other words, you think there is a dosage level that is safe from radiation, ionizing radiation?

Dr. McIndoe. I think in my field of work the standards that I am working under are acceptable to me and safe, yes, sir.

Mr. Rogers. Have you read any literature that brings that under question?

Dr. McIndoe. Yes, sir, I have read literature that questions the long-term effects of low-dose radiation; and I have not been convinced in my own mind that they have any more correct interpretation of their data than other people do. We are into a very "queasy" area in terms of almost philosophy, rather than physics.

Mr. Rogers. Well, would you agree with the statements of Dr. Morgan that no level is completely safe?

Dr. McIndoe. When did I start beating my wife. I cannot answer that, sir, in an honest manner. We are under radiation all the time, and it differs in various areas of the world, in airplanes, et cetera. So, we are constantly under bombardment. And what the limiting factor is I do nor know.

Mr. Rogers. Is your training in radiological——

Dr. McIndoe. I am trained in internal medicine and nuclear medicine.

Mr. Rogers. Have you done experiments in radiation?

Dr. McIndoe. Personally, sir?

Mr. Rogers. Scientific experiments on dose levels, and so forth?

Dr. McIndoe. No, sir. I am not personally involved in the radiation physics area.

Mr. Rogers. How reliable are the reports of operations which place military troops at certain distances from ground zero, would you say; has that been looked at at all?

Mr. Haas. I believe they are reasonably reliable, Mr. Chairman. I cannot personally vouch for them, but I am reasonably well acquainted with many of the people who are responsible for the reporting and I have no reason to believe that if they state certain facts regarding radiation levels encountered and measured, and distances that the troops were placed, that these are not indeed correct.

Mr. Rogers. Well, we had witnesses this morning, for instance Colonel Keating, who was a commanding officer and helped design the project, he said they were within 1½ to 3 miles and then went up closer than that. And the Army report says 8,500 yards, 5 miles.

Then we also had Mr. Dann testify that he was much closer than 5 miles, in fact, 2,000 to 3,000 yards. And the Army said his unit was 8 miles. Now, they had some trenches but they pulled them out of the trenches just before because of a wind shift.

Mr. HAAS. Mr. Chairman, we now have that record and the testimony, and we certainly do intend to compare it with the facts as described in the reports, and comment on them for the record for you.

Mr. ROGERS. Yes, if you would, please. Have you made any effort yet to interview actual participants to help locate troop positions?

Mr. HAAS. No, we have not sir.

Mr. ROGERS. Were there any safeguarads to reduce troop exposure to radioactive dust?

Mr. HAAS. Not to the best of my knowledge, Mr. Chairman.

Mr. ROGERS. Were troops warned of any possible risk from radioactive dust particles?

Mr. HAAS. I do not know. Maybe Major Skerker can comment on that.

Mr. ROGERS. Thank you.

MAJOR SKERKER. There were no respirators in use, and that being the case, you could not really warn a man not to breathe in.

Mr. ROGERS. It would not do much good to give him a warning, would it.

MAJOR SKERKER. Right.

Mr. HAAS. I will say this, Mr. Chairman, as a scientific participant I certainly was warned of that information, and in dusty areas did wear appropriate gear. I was warned.

Mr. ROGERS. But they were not issued to the troops, were they?

Mr. HAAS. I was not issued anything personally, either.

Mr. ROGERS. But you had it and wore it.

Mr. HAAS. I had Band-Aids and covers for my mouth, which were worn on occasion. I do not know whether they were issued to the troops.

Mr. ROGERS. Well, the evidence has been that it was not, perhaps the major can tell us.

Major SKERKER. That is correct, sir, I have no evidence that they were.

Mr. ROGERS. Issued anything? Not really warned of the potential damage?

Major SKERKER. No, sir.

Mr. ROGERS. Dr. Carter?

Mr. CARTER. Thank you, Mr. Chairman, I have only a few questions.

I would like to know, Doctor, Colonel, you are a radiologist I take it; you specialize in radiology?

Dr. MCINDOE. No, sir, internal medicine and nuclear medicine.

Mr. CARTER. Internal medicine and nuclear medicine. What was the first burn from radioactive material?

Dr. MCINDOE. Most likely I would say it was one of the Curies——

Mr. CARTER. No. it was not Madame Curie or her husband. It was one of their associates who inadvertently had a piece of radium in his pocket, and he was burned. He reported it to Madame Curie, and then her husband experimented with it and found that he was burned, also. I believe you will find that a matter of history.

Now, how many people retired from the Army, have been retired from the Army as a result of cancer caused by atomic radiation?

Dr. MCINDOE. I have no knowledge on that question, sir.

Mr. CARTER. Have any of servicemen ever been retired or received a medical discharge as a result of these tests?

Mr. HAAS. We do not have the answer to that question, we will try to obtain that from the Surgeons General of the services, sir.

[The following information was received for the record:]

As of this date we have not been able to identify any Serviceman who has been retired from any Service for "cancer caused by radiation." We have directed the Services to research this matter. If any retirements are determined to have been caused by cancer induced by radiation, the Subcommittee will be promptly notified.

Mr. CARTER. I see. What are the symptoms of radiation sickness, Doctor?

Dr. MCINDOE. Much of that depends upon the dose, the rate of delivery. The symptoms may range from a simple loss of appetite and fatigue to an extensive physiologic response manifested by nausea, vomiting, and unconsciousness.

Mr. CARTER. With moderate radiation sickness we would think of nausea, vomiting, diarrhea, and also nosebleed; is that not true?

Dr. MCINDOE. That is true, sir. That would be one of the symptoms that would occur several days after exposure.

Mr. CARTER. Well, in some cases it has occurred at the time of these tests, including Smoky, and those who have now developed leukemia, and yet they have not been compensated.

Major, do you believe that an observer at Smoky was likely to have been knocked over by the blast and high winds?

Major SKERKER. At 3,000 yards the winds were indeed about 80 miles an hour. At 8 miles the winds were 7 miles an hour. At 8 miles you could not be knocked down; at something like 3,000 yards it was testified earlier this morning that you certainly would be knocked down.

Mr. HAAS. Dr. Carter, may I insert one comment on an earlier question of yours regarding the report of a 7-knot wind at Shot Smoky? That was described in the report as the wind either before the shot, or long after the shot had passed; in other words, the fallout-related wind. Indeed, you are quite correct, at the point where the troops were, at 3,000 yards, the wind, as Major Skerker just commented, was much higher than 7 knots.

Mr. CARTER. What would the wind speed from the blast have been at 8 miles?

Major SKERKER. I computed that at 7 miles.

Mr. CARTER. Sir?

Major SKERKER. At 8 miles distance the blast windspeed would be approximately 7 miles per hour.

Mr. CARTER. At the time of the blast?

Major SKERKER. At 8 miles, yes, sir; not closer, but at 8 miles.

Mr. CARTER. At 8,500 yards?

Major SKERKER. At 8 miles, sir, which would be something more like 14,000 yards.

Mr. CARTER. And I am now asking, at 8,500 yards what would the wind speed have been at the time of the blast?

Mr. HAAS. Dr. Carter, that should be approximately 35 miles per hour.

Mr. CARTER. Thirty five miles per hour.

Mr. HAAS. That is correct.

Mr. Carter. At 8,500 yards. Then it would not, of course, have knocked a person down.

And, again, 3,000 yards what would have been the speed of the wind?

Mr. Haas. I would have to give you an exact number for the record, but I would estimate it would be slightly above 100 miles per hour.

Mr. Carter. Did I understand you to say 40 miles per hour?

Mr. Haas. At 100 miles per hour.

Mr. Carter. What did you calculate it earlier today, Major, the windspeed at 3,000 yards?

Major Skerker. The calculation that I made, that I gave to the committee staff, was at 8 miles observation, and that was at 7 miles per hour.

Mr. Carter. What would it be at 3,000 yards, then, Major?

Major Skerker. Somewhere between 80 and 100 miles an hour.

Mr. Carter. You say 80 to 100 miles per hour. You differ then from our distinguished——

Mr. Haas. We have an agreement. I would agree that at 8 miles, Dr. Carter, it would be about 7 miles per hour.

Mr. Carter. All right, then you agree on 7 miles per hour at 8 miles away.

Mr. Haas. And I would also agree that at about 3,000 yards it would be closer to about 100 miles per hour.

Mr. Carter. Yes, sir. As a radiologist, doctor, what strength of X-rays would it take for someone to see his bones without a fluoroscope?

Dr. McIndoe. I do not believe that could be done at all, sir. I do not believe the human eye is capable of distinguishing X-rays. I think if the light was bright enough——

Mr. Carter. Well, of course you are not seeing the X-rays, you are seeing the bones. We had testimony to that effect by one man this morning; and we have had the same testimony by others.

Dr. McIndoe. There is no doubt, sir, I believe they did.

Mr. Carter. Sir?

Dr. McIndoe. I have no doubt that they did see their bones, but that would be because of the light, not X-ray.

Mr. Carter. Sir?

Dr. McIndoe. That would be from the light, visible light, not from the radiation.

Mr. Carter. Well, we know that the gamma rays travel with the speed of light, do we not? I fail to see how you can separate one from the other. I do not believe you can.

Thank you, Mr. Chairman.

Mr. Rogers. Could you not actually figure what the radiation was that a person would receive at 3,000 yards from zero?

Mr. Haas. I have that information, Mr. Chairman. At 3,000 yards a person would promptly receive a radiation dose of about 6.3 rads of gamma radiation and something slightly less than 2 rads of neutron radiation if he was completely unshielded, standing out in the open, from Shot Smoky.

Mr. Rogers. Do clothes give sufficient shielding?

Mr. Haas. Clothes would give you no shielding whatever.

Mr. Rogers. What would give you shielding?

~~Mr. HAAS.~~ Appreciable thicknesses of lead or some other heavy material.

Mr. ROGERS. So, a man who had his helmet blown off, was knocked down, would not have much protection.

Mr. HAAS. If he were in a trench he would have an appreciable amount of protection. Out in the open he would have none.

Mr. ROGERS. And so he would have gotten a dose, then, of at least—approximately over 6.

Mr. HAAS. And his film badge would so read. That prompt radiation would be gamma neutron radiation mix, and his film badge would then read something in the neighborhood of about 7 to 8 rads.

Mr. ROGERS. Now, let me ask you this, 6 to 7 rads, what was the procedure if such a badge showed up? It was sent away to be read, as I understood it: was it not?

Major SKERKER. Yes, sir.

Mr. ROGERS. And what happened?

Major SKERKER. We can not really identify a complete audit trail beyond the notification through the Desert Rock surgeon and the man's home unit as to what would happen. We have evidence in some cases of overexposure where a statement was made that blood tests taken and showed negative, but I have no document that can show a medical followup program of the type you suggest.

Mr. ROGERS. So there was no medical followup.

Major SKERKER. I simply have not found evidence of it.

Mr. ROGERS. And what was the decontamination procedure? One of them said they told him to flip his jacket to get the dust off of it, and he brushed his boots with a whisk broom. Is that the procedure?

Major SKERKER. The initial types of decontamination procedues would in fact be to dislodge the loose material from the clothing or vehicles; that would mean brooming down, hosing down, things like that. Silly as it may sound, that is a factor.

Mr. CARTER. What about that material he had inhaled in his lungs?

Major SKERKER. What we are suggesting there, everything he shook off, he breathes in. You are right, sir, I mean, some amount of that, that you would shake off from your body would be resuspended and inhaled.

Mr. ROGERS. And I presume the helicopters had a tendency to stir that up again for them to breathe. Would that be correct?

Major SKERKER. Some dust in the air, some of it, you are going to breathe. It is probably an almost impossible problem to really calculate how much a man does breathe in a given situation. But certainly, dust in the air will be breathed.

Mr. ROGERS. What do your records really reveal was the point of Smoky, say? It indicated it was a public relations exercise.

Mr. HAAS. I don't quite understand, Mr. Chairman, how that comment was made.

Mr. ROGERS. It was made in your report.

Mr. HAAS. In the Army's report, yes, sir. As I pointed out earlier to the subcommittee, shot Smoky had many other needs and was set off for an entirely different reason than that for the Army troop exercise. It was an AEC shot and it had a military application of a different type than for the troop exercise. Now, if the Army said that they did the troop exercise. Now, if the Army said that they did the troop exercise aasociated with Shot Smoky as public relations exercise—as you have read from the report—I unfortunately cannot speak to that comment.

Mr. ROGERS. Well, is it not also possible for them to have exercises with a simulated bomb explosion?

Mr. HAAS. Simulated bomb explosions?

Mr. ROGERS. Yes. In other words, to project what would happen, do you not use troop exercises—someone said they were using the pentomic unit.

Mr. HAAS. I am certain, Mr. Chairman, that such simulated exercises can be held; and in fact I believe the Army has in past years had such exercises. I sort of have doubts whether they are anywhere near as effective in troop familiarization.

Mr. ROGERS. If you set off a bomb, that is more realistic than if you do not. But I am not sure of the overall effect on the health of the soldiers, not knowing what those dangers are.

Mr. HAAS. I would agree with you on that judgment, Mr. Chairman, today. But you must remember that those decisions were made at a different time, under different circumstances.

Mr. ROGERS. I understand, and I understand you were not there making them.

Major, does the Army now conduct any tests of this nature?

Major SKERKER. No, sir.

Mr. ROGERS. Do they simulate them?

Major SKERKER. Yes, sir; we do use simulator devices.

Mr. ROGERS. Do they have danger to the troops, the simulated devices?

Major SKERKER. Nothing beyond the fact that it is pyrotechnic-type device.

Mr. ROGERS. But no problems with radiation.

Major SKERKER. No radiation problems.

Mr. ROGERS. So, you still go through the exercises, but without setting off a bomb.

Major SKERKER. That is correct, sir.

Mr. ROGERS. I am sure as we go through this material we would like to ask additional questions, and we will submit some for the record that we would like to have answered. Let me just conclude by asking this: How does the Department of Defense propose to conduct followup studies of those who participated in nuclear test programs?

Mr. HAAS. Well, as we testified, Mr. Chairman, we did meet in December with the other agencies and jointly did come to an agreement to fund a parallel study with the National Research Council of the National Academy of Sciences, who, we all jointly agreed, was a responsible research organization. We have asked them since then to develop a medical protocol for that purpose, one over which, I might point out, none of the agencies involved would have the slightest bit of control. The National Research Council does not allow that sort of thing.

Mr. ROGERS. How would it be funded?

Mr. **HAAS**. We have agreed, Mr. Chairman, that each of the agencies participating would fund that study to whatever extent it would be necessary.

Mr. **ROGERS**. Would it be on a year-by-year basis, or total funding?

Mr. **HAAS**. Our funds provided by the Congress are on an annual basis, Mr. Chairman, and so it would have to be on a year-by-year basis. But certainly, it would be included in our budget for both fiscal years 1978 and 1979.

Mr. **ROGERS**. Well, I would think if you made a request for the Congress to fund an independent properly designed study, the Congress would be willing to look at 2, 3, 4 years. Hopefully it could be done in less than that.

Mr. **HAAS**. I am quite certain, Mr. Chairman, that the Congress would be most receptive to that suggestion. I do not believe it is necessary. I think within the funds available to the Department of Defense this type of high priority study would certainly receive any adequate considerations in funding as may be required.

Mr. **ROGERS**. I think the committee would like to know that. If you would let us know.

Mr. **HAAS**. I would aasure the chairman that the Defense Nuclear Agency would stand ready to make the funds for the NRC study available, whatever may be needed.

Mr. **ROGERS**. Thank you.

Now, would the Defense Department have the right of approval of the study protocol?

Mr. **HAAS**. I do not believe, Mr. Chairman, that the Defense Department would consider that it would have such a right of approval; but I would believe from my years of experience with the National Academy that they would sort of waive that off and say, "We are the only ones that have the right of approval to our protocols."

Mr. **ROGERS**. Does the Department of Defense have any objection to letting CDC continue the study?

Mr. **HAAS**. We have from the very beginning, Mr. Chairman, agreed to continue to support Dr. Caldwell, as we did from the very first day that he came to us. We consider that to be a parallel effort. And if funds should be requred for the study—and we have not been notified by the Department of Health, Education, and Welfare that they will be—we would make those available, also.

Mr. **ROGERS**. So, you would have no objection to CDC doing the broader study.

Mr. **HAAS**. Absolutely not, Mr. Chairman.

Mr. **ROGERS**. Thank you. That is very helpful.

Mr. **CARTER**. Mr. Chariman, I have just a few questions. In 1957, or back even in 1951, 1952, or 1953 or other years when we were doing these atomic explosions, was the state of science such that we knew the effect of these explosions on human beings?

Mr. **HAAS**. Well, we have learned through experiments over the years.

Mr. **CARTER**. But did we know the effects?

Mr. **HAAS**. More and more. I would certainly agree, Mr. Carter, we know more today, a lot more today than we did in 1957.

Mr. CARTER. Yes. Then we should say, then, "Father, forgive us, for we knew not what we did." We did not have full knowledge at that time, did we?

Mr. HAAS. We certainly had less knowledge.

Mr. CARTER. That is the point I am trying to make.

Mr. HAAS. Certainly, we had much less then, than we do now.

Mr. CARTER. Thank you very kindly.

Mr. ROGERS. Finally, I am very anxious to ask you along with the Secretary of Defense, to look into if necessary, increasing the personnel to give some priority to this project of searching out the records and making them available to CDC. Do you see any problem with that?

Mr. HAAS. Mr. Chariman, before I came over here this morning I had only my third conversation in 2 days with Dr. John White, the Assistant Secretary of Defense for Manpower Reserve Affairs, and Logistics, who is presently the Acting Assistant Secretary for Health Affairs. I believe on the basis of that conversation I have every aasurance that the Department of Defense proposed to followup the committee's recommendations as speedily as is possible.

Mr. ROGERS. Would you let us know tomorrow what is projected in increasing manpower and effort, and the time element the committee may expect?

Mr. HAAS. I will attempt to answer that.

Mr. ROGERS. If not, would you advise us who makes the decision, and the committee will also contact him?

Mr. HAAS. I will attempt to give you that information as quickly as possible

Mr. ROGERS. Thank you very much. Dr. Carter?

Mr. CARTER. Was Smoky a particularly dirty explosion?

Mr. HAAS. I cannot believe that is an appropriate statement, Mr. Carter. I do not think shot Smoky was any more dirty than any other shot. It was on a tower. It was certainly more dirty, if that would applies, than shots which were suspended from balloons, like shot HOOD was, which was at a higher altitude.

Mr. CARTER. Your opinion being that way, can you explain why the AEC personnel turned their backs and ran and would not go in to retrieve the instruments placed at Smoky for several days? Why did they do that, if it was not more dirty than previous shots?

Mr. HAAS. I am afraid I cannot answer that.

Mr. CARTER. There is a little difference of opinion here, then, is there not?

All right, thank you very kindly.

Mr. ROGERS. We will be furnishing you questions to be answered for the record, if you would, and also a statement from Mrs. Jones who testified today, that we would ask you to reply to for the record.

Mr. HAAS. Thank you, Mr. Chairman.

[The following information was received for the record:]

While the Department of Defense shares Mrs. Jones' concern in ensuring that the U.S. Government fulfills its responsibility to former servicemen, DOD most emphatically does not concur with her sweeping allegations.

First, throughout her statement Mrs. Jones prejudges the issue of whether low-level ionizing radiation increases the risk of leukemia or other cancers. The scientific community my no means accepts this relationship, and this is precisely the issue into which the Committee is inquiring. It is the subject of the study now underway at the Center for Disease Control; and it is expected to be the focus of an even broader effort by the National Reserch Council of the National Academy of Sciences. To provide detailed data for these scientific reviews, DOD has recently embarked upon an extensive program to devlop the details of personnel participation and exposure in each test. The Department of Defense believes strongly that the outcome of the scientific reviews should not be prejudged as Mrs. Jones does.

Second, the DOD strongly disagrees with Mrs. Jones' statement that "the study which is being carried on by the Center for Disease Control is unnecessary and is itself an attempt to endlessly delay and cover up this entire issue." The DOD has great respect for the independence and competence of the Center for Disease Control, and is doing everything possible to assist them in their work. The DOD believes CDC should continue its work.

Third, DOD takes strong issue with Mrs. Jones' broad "charges" on behalf of Another Mother for Peace. However, the details of the specific instances she alleges will be investigated in detail, in conjunction with the far-reaching DOD research program now getting underway. Detailed information will be made available to the Committee as it is developed.

Mr. ROGERS. Thank you for your patience with the committee, we appreciate your testimony today.

The committee stands adjourned until 10 o'clock tomorrow morning.

[Whereupon, at 5:05 p.m. the subcommittee adjourned, to reconvene at 10 a.m., Thursday, January 26, 1978]

EFFECTS OF RADIATION ON HUMAN HEALTH

Health Effects of Ionizing Radiation

THURSDAY, JANUARY 26, 1978

House of Representatives,
Subcommittee on Health and the Environment,
Committee on Interstate and Foreign Commerce,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10:20 a.m., in room 2123, Rayburn House Office Building, Hon. Paul G. Rogers, chairman, presiding.

Mr. Rogers. The subcommittee will come to order, please.

The committee is continuing its hearings on the health effects of ionizing radiation. We will hear this morning from the Department of Energy. The witness is Dr. Donald Kerr, the Acting Assistant Secretary for Defense Programs, Department of Energy.

We welcome you to the committee, Dr. Kerr, and if you have colleagues that you would like to have join you at the table, they are welcome to do so. If you would identify them for the record, it would be helpful. Your statement will be made a part of the record in full, without objection, and you may proceed as you desire.

STATEMENT OF DONALD M. KERR, PH. D., ACTING ASSISTANT SECRETARY FOR DEFENSE PROGRAMS, DEPARTMENT OF ENERGY, ACCOMPANIED BY GORDON JACKS, LOS ALAMOS SCIENTIFIC LABORATORY, N. MEX.; BOB NEWMAN, DEPUTY ASSISTANT MANAGER FOR OPERATIONS, NEVADA OPERATIONS OFFICE; BRUCE CHURCH, BRANCH CHIEF FOR RADIATION SAFETY, NEVADA OPERATIONS OFFICE; RICHARD AMICK, OFFICE OF GENERAL COUNSEL, NEVADA OPERATIONS OFFICE; WALTER WEYZEN, M.D., DIVISION OF BIOLOGICAL ENVIRONMENTAL RESEARCH, MANAGER, HUMAN HEALTH STUDIES PROGRAM, NEVADA OPERATIONS OFFICE; HAL HOLLISTER, DIRECTOR, DIVISION OF OPERATIONAL AND ENVIRONMENTAL SAFETY; WILLIAM BURR, JR., M.D., DEPUTY DIRECTOR, DIVISION OF BIOMEDICAL AND ENVIRONMENTAL RESEARCH; ROBERT TAFT, ASSISTANT MANAGER FOR PLANS, ENGINEERING AND BUDGET, NEVADA OPERATIONS OFFICE; AND VICTOR BOND, M.D., ASSOCIATE DIRECTOR OF BROOKHAVEN NATIONAL LABORATORY

Dr. Kerr. Mr. Chairman, members of the committee, it is a privilege to appear before you today on behalf of the Department of Energy.

It is my understanding that this committee has concern about past nuclear weapons test explosions and their possible adverse health effects upon people who participated in those test operations and upon people who were not associated with those operations, but who were at locations where they might have received radiation exposure. I would like to read a prepared statement to furnish you with some general information to expand upon the testimony you have heard from the DOD witnesses yesterday. With your permission, I would like to submit the statement along with backup material for the record.

Mr. ROGERS. Without objection, that material will be received for the record [see p. 341].

Dr. KERR. After my presentation, I will try to answer questions having to do with the testing operations and the safety of those operations. Here to assist me in answering questions are several people. In introducing these gentlemen, I should comment that all U.S. atmospheric weapons testing was done before the end of 1962. While there are people here who participated in some of the atmospheric tests, not one of us here today was in a top management role in 1957. Memories tend to be less reliable as to what happened 20 to 30 years ago. My comments will include some historical information obtained from records, but must rely to some extent upon the recollections of participants.

Mr. Hal Hollister, to my right, is the director of the Division of Operational and Environmental Safety in the Department of Energy. He is here on behalf of Dr. James Liverman, Acting Assistant Secretary for Environment. Mr. Hollister may be able to assist if there are questions regarding the health, safety, or environmental safety of operational procedures.

Mr. ROGERS. We welcome you, Mr. Hollister.

Mr. HOLLISTER. Thank you very much.

Dr. KERR. Dr. William Burr, sitting to the right of Mr. Hollister, is the deputy director of the Division of Biomedical and Environmental Research, also under Dr. Liverman. He should be able to help with regard to matters having to do with the health effects of radioactivity.

Mr. ROGERS. Dr. Burr, the committee is glad to have you.

Dr. KERR. Mr. Bob Newman, sitting behind me, is presently the deputy assistant manager for operations at our Nevada Operations Office, responsible for the Nevada test site. He is one of the present Nevada test controllers, the individual who is solely responsible for the detonation of a nuclear device, appointed by the manager to take overall responsibility for and control of test operations during the period from the day before each test until satisfactory completion.

Mr. ROGERS. Mr. Newman, the committee is glad to have you.

Dr. KERR. Mr. Robert Taft, assistant manager for plans, engineering and budget of the Nevada Operations Office, in the row behind Mr. Newman, had responsibilities at the Pacific proving ground from 1952 through 1957, during the intervals between test operational periods.

Mr. ROGERS. Mr. Taft, welcome.

Dr. KERR. Mr. Bruce Church is chief of the radiological branch in the Nevada Operations Office. In that position he has responsibilities for the day-to-day radiological safety at the Nevada test site. Mr. Church is sitting to my right.

Mr. ROGERS. Mr. Church, the committee is glad to have you.

Dr. KERR. Mr. Richard Amick is from the Office of Chief Counsel at the Nevada Operations Office and is informed on certain legal matters associated with testing operations. He is sitting to the rear.

Mr. ROGERS. Yes; we see Mr. Amick; thank you for being here.

Dr. KERR. And finally, just behind me is Mr. Gordon Jacks from the Los Alamos Scientific Laboratory, where he is a senior member of the permanent Los Alamos contingent at the Nevada test site. In 1957 he was employed by the University of California Radiation Laboratory to assist in the AEC's radiological safety program at the NTS. He should be able to help with questions about radiological safety as it was handled by the AEC at the time of Smoky. Also, he was responsible for the radiological safety of the scientific task group during Pacific tests in 1956, 1958, and 1962, and handled the dosimetry program for the entire task force in those years.

Mr. ROGERS. Mr. Jacks, the committee welcomes you.

Dr. KERR. A number of other persons are present who have had a variety of experience that relates in part to the effects of nuclear explosions in the atmosphere. Should there be questions in their specific areas of expertise we will introduce them, should they be able to help you.

Mr. ROGERS. That will be fine.

Dr. KERR. We will try to answer your questions at this time. However, if there are areas which we are unable to cover satisfactorily, particularly in the medical effects area, we will provide that information to the committee in written form. In addition, Dr. Liverman will be testifying before you on February 8, if there are matters we cannot cover today.

Mr. ROGERS. Thank you very much, Dr. Kerr.

Dr. KERR. I will begin by addressing the scope of the U.S. nuclear weapon test program. The United States has continued to conduct tests of nuclear weapons since the Trinity Test in 1945. Such testing has been essential to the research, development and production of nuclear weapons. By law, the Department of Energy now has responsibility for the nuclear weapon R. & D. program, including testing originally carried out by the Atomic Energy Commission, and later the Energy Research and Development Administration.

The United States has conducted 606 announced nuclear detonations from 1945 to the present. Of these, 484 were fired at the Nevada test site, 105 at locations in the Pacific Ocean testing areas, including Bikini, Enewetak, Johnston Island, and Christmas Island; and the remaining tests were at various other locations. Approximately one-third of the total were atmospheric weapon tests; 86 of these were at Nevada. The United States had stopped all atmospheric testing before 1963, the year of the Limited Test Ban Treaty. From that point on all U.S. weapon tests have been conducted underground with the intent of containing radioactivity.

I have a detailed list of all of the tests [see p. 341], should it be useful to the committee's inquiry.

Mr. ROGERS. I think it would be helpful, and it will be received for the record. Thank you.

Dr. **Kerr**. You may have noticed that the totals I gave above were for announced U.S. detonations. For security reasons, not all weapon tests are announced. I would like to point out also that there have been a few Plowshare, or peaceful nuclear explosive tests. These were cratering tests as distinct from nuclear weapons tests. While these explosions were carried out with the same basic operational procedures as weapon tests, those peaceful nuclear explosive tests were not designed for complete containment. Today I am discussing nuclear weapon tests.

Since the major purpose of all tests was to learn how well the various weapons design concepts actually performed, most tests were done in such a way that scientific measurements could be made. Initially, the most satisfactory technique was to position the weapon on top of a tower and to arrange instruments in an array around that tower to observe the detonation. However, for effects measurements, a few weapons were also positioned underwater, underground, or at the ground or water surface. Such surface bursts were not often employed because of the larger amount of fallout produced. A few were dropped from aircraft or delivered to the detonation point by some other military delivery system. Towers were very expensive, and they contributed to the radioactive fallout; hence, the AEC soon looked for better methods of weapon emplacement. The first successful alternative was suspension of the test device beneath a helium balloon, which was held at the desired firing point by a set of mooring wires. Several tests were fired at Nevada locations as high as 1,500 feet above the ground, using this technique.

In 1956, the AEC began development of underground testing methods to reduce fallout. One technique was to tunnel horizontally under a mountain, to emplace the device, and to plug or stem the tunnel opening. Some early underground tests were not satisfactorily contained and it required several years of underground testing experience to learn the successful techniques now employed to contain underground nuclear explosions in tunnels. Another technique was to drill a vertical hole in which the device was emplaced and fired. It is the drilled underground emplacement which later was successfully developed for most underground testing.

A great deal of information has been made public on the health aspects of atmospheric nuclear testing. During hearings held in May and June of 1957, and May 1959 by a Special Subcommittee on Radiation of the Joint Committee on Atomic Energy, and in June of 1962 by the Subcommittee on Research, Development, and Radiation of JCAE, an extensive record of these matters was compiled.

The summary analysis of the 1957 hearings indicated that there is a difference of opinion as to whether a very small dose of radiation would produce an increased incidence of such somatic conditions as leukemia or bone cancer. In the 1959 hearings the summary analysis indicates that the biological significance of low levels of radioactivity was at that time still largely unknown. No resolution was reached on whether or not a threshold level of radiation exposure exists below which effects such as cancer and leukemia do not result.

The summary analysis of the 1962 hearings found that the difference of opinion expressed at the 1959 hearings on whether there is a threshold level of exposure, below which somatic effects will not occur in the body, has yet to be settled within the scientific community. While radiation protection standards continue to be based on a linear or no threshold assumption, it is possible that the true radiation risk for somatic effects at levels near or several times higher than the national background may prove to be smaller than would be predicted by their assumption, and may possibly be zero.

The Federal Radiation Council considered "Health Implications of Fallout From Nuclear Weapons Testing Through 1969" in its report No. 3, "Estimate and Evaluation of Fallout in the United States From Nuclear Weapons Testing Conducted Through 1962" in its report No. 4, and "Revised Fallout Estimate for 1964-65 and Verification of the 1963 Predictions", in its report No. 6. Those reports present the conclusions that fallout in the United States in relative terms will be far short of figures which would cause concern or justify countermeasures.

I will now go on and describe the atmospheric nuclear testing from 1946 to 1962.

After World War II, the first series of weapons test operations took place at Bikini Atoll within the U.S. trust territories in the Pacific. These tests and those test series that followed elsewhere in the Pacific were enormous operations which necessitated large-scale military participation to furnish the necessary logistic support.

Mr. ROGERS. Pardon me, may I interrupt at this point? Do you have the figures, the numbers of military personnel who participated there?

Dr. KERR. I believe we do, sir.

Mr. ROGERS. Would you furnish those for the record, please, and could you tell us approximately what they are in overall figures?

Dr. KERR. We would have to extract that information from the joint task force reports for each operation, which we could then provide you for the record. We do not have a separate listing of military and civilian participation with us at this hearing.

Mr. ROGERS. Do you have the overall figure of civilian and military?

Dr. KERR. Yes; we do.

Mr. ROGERS. What is that, then, please? And then submit for the record, if you would please, the breakdown [see p. 407].

Dr. KERR. To give you a direct answer now, prior to submitting it for the record, the totals of personnel in our exposure records for testing years from 1945 to the present are 347,640 for tests in the continental United States, and 110,650 for Pacific tests. There are some qualifications with those totals, the first being that records for some Pacific operations and continental tests prior to 1957 may include multiple entries for the same person. Second, records do include exposures during nonoperational periods, when no tests were conducted. And, as you learned yesterday, not all participants appear in the records because all personnel were not film badged during every Pacific and continental test operation, particularly official observers outside the controlled area and Desert Rock troops on exercises. Army film-badge data from 1951, 1952, and

1957 are included in the above totals because these records were obtained from the Lexington Army Signal Depot archives.

Mr. ROGERS. Thank you.

Dr. KERR. The organization for each of these operations was a joint task force in which there was a designated overall military commander who represented both the DOD and the AEC, and within which there were scientific as well as military task groups. Typically, the task force commander had a civilian scientific deputy commander who mainly looked after matters having to do with the tests themselves.

While the task force commander had within his organization a radiological safety adviser, each major task group within the joint task force was responsible for furnishing its own radiological safety support. The scientific task group had a radiological safety unit responsible for protecting those scientific participants who might be exposed to radiation hazards during scientific experiments, and for providing all joint task force dosimetry services.

Also, this radiological safety unit looked after some other individuals, including AEC contract support personnel and official observers. The radiological safety operations which supported the scientific efforts were provided mainly through military personnel who were temporarily assigned to the scientific task group for the period of the test series. During nonoperational periods, when no tests were being conducted, the AEC and its contractor provided the radiological services.

On the other hand, for nuclear weapon testing within the continental United States, all aspects of conducting and managing operations normally were assigned to an AEC test manager who had been designated by the Commission. The personnel from the AEC laboratories, projects of the field command, Armed Forces special weapons project, and the U.S. Civil Effects Test Group, plus members of the AEC and official AEC guests, all were considered to be onsite participants for whom the AEC test manager exercised safety responsibilities. However, "onsite participation" did not include personnel sent to the Nevada Test Site under the auspices of the DOD Desert Rock program. Camp Desert Rock was outside the Nevada test site and all aspects of the Desert Rock exercises were separated from onsite activities as much as possible. With regard to that DOD program, the responsibility for radiological safety of troops differed from one test series to the next. For the tests in 1951, the AEC had radiological safety responsibility for troops. In 1952, the AEC accepted joint responsibility with the DOD for radiological safety of Desert Rock troops. Beginning in 1953 and continuing through 1957, the AEC at the request of the Department of Defense delegated responsibility for the radiological safety of troops to the DOD. During those latter years, the DOD commander of the Desert Rock exercises provided the AEC test manager with operation plans in advance of those tests on which there was to be troop participation. However, except for a few interactions through an AEC/DOD liaison officer, the Desert Rock exercise forces were independent and furnished their own radiological safety and support. The Desert Rock exercise during Event Smoky was done under this arrangement.

Radiological safety support for the AEC at the Nevada Test Site through the 1955 Teapot operation was obtained using personnel from the AEC's weapons laboratories and the Department of Defense. After the 1955 Teapot operation this arrangement was changed completely. All facets of AEC onsite radiological safety were performed for the Commission by Reynolds Electrical & Engineering Co., better known as REECO. That group furnished film badges and provided radiological support in connection with measuring radiation exposures and maintaining and reporting dose records. They furnished radiological monitoring personnel and instruments for use in protection of all onsite personnel at the test site. They provided radiation safety briefings to onsite personnel whose work might take them into radiation fields. REECO furnished decontamination facilities, and assistance for personnel and equipment. Also, radiation health medical facilities were maintained. Further, REECO implemented the AEC procedures after each test for controlling access to contaminated areas, and they performed routine environmental monitoring at the Nevada Test Site.

AEC, ERDA, and now the Department of Energy have had REECO continue in its role of furnishing complete radiological safety support at the test site. It is REECO today that has a computer file listing exposure records for people involved in nuclear weapon testing. Their file includes that data which has been furnished by the DOD for military personnel exposures as the witnesses described yesterday.

The AEC offsite radiological safety program, during test periods from 1951 through 1954, was directed by the Los Alamos Scientific Laboratory. Experience gained by the AEC during this period indicated that monitoring and documenting of radioactivity that escaped from the test site could be more effective if it were performed by a health agency. In 1954, a memorandum of understanding was drawn up between the Commission and the Public Health Service to provide a comprehensive program for radiological safety beyond the boundaries of the test sites. Objectives of the offsite program include protecting the public from the effects of nuclear tests; documenting exposures in the offsite areas; providing a public information and education program; and investigating incidents of possible radiation injury. The Public Health Service provided the public safety program until this function was transferred in 1970 to the Environmental Protection Agency's Environmental Monitoring and Support Laboratory in Las Vegas, Nev., which has continued this program.

In the atmospheric testing period from 1951 to 1962, maximum permissible amounts of radiation exposures for test participants generally were established or adopted prior to each nuclear testing operation by the test manager or the joint task force commander. However, permission was given by the test manager or the task force commander for certain participants to exceed the maximum permissible amounts. Those personnel performed particularly critical assignments such as cloud sampling and recovery of scientific instrumentation or data; they were not Desert Rock troops.

Maximum permissible exposure amounts changed over the years, depending on the national and international committee recommendations, but the primary standard of quarterly or 13-week whole-body penetration radiation exposure has not changed greatly. For example, this amount was 3.9 roentgens during the NTS Ranger operation in 1951, and was 3 rem—that is roentgen equivalent man—from 1962 to the present.

A complete listing of personnel exposed beyond the permitted amounts has not been compiled, and this would require considerable research regarding numbers of personnel and the limits in effect during each operational period. An incomplete review of available documents revealed that about 900 test participants exceeded the permissible exposure amounts for whole-body penetrating radiation during atmospheric testing operations.

As nuclear weapons testing progressed into the late 1950's, this country as well as many others became increasingly concerned about the nuclear arms race and about the associated nuclear testing activities which at that time were being conducted in the atmosphere. In particular, fallout from these testing activities became of such great concern that the United States and the Soviet Union both had stopped all nuclear testing by early November 1958. This moratorium remained in effect until abrogated by the Soviet Union in September 1961. Soon after, in the interest of national security, the United States resumed a nuclear test program of its own.

However, concern still existed over worldwide fallout from nuclear testing. Diplomatic negotiations had been taking place, and they culminated in the signing of the Treaty Banning Nuclear Tests in the Atmosphere and Outerspace and Underwater—more widely known as the Limited Test Ban Treaty—by the United States and Soviet Union in August 1963. All United States weapons tests since 1963 have been carried out underground.

Since the Limited Test Ban Treaty, there have been 19 releases of radioactivity detected offsite. Most of these releases occurred in the 1960's when the state-of-the-art in underground containment had not been developed to its present technological level. The last significant release was from the Baneberry event in December 1970.

Promptly after the venting of Baneberry, in mid-December 1970, the general manager at AEC Headquarters and the manager Nevada operations office, initiated separate investigations to determine causes and necessary corrective actions. The AEC directed that no further testing would be authorized until appropriate reports and evaluations were completed. The conclusions from the investigations indicated that the venting resulted from a unique geologic environment surrounding the Baneberry device. It was also concluded that the initiation of a number of administrative and technical actions would provide confidence to resume a test program with considerably reduced probability of a recurrence of a venting similar to Baneberry. These actions required changes in procedures or in emphasis to attain additional assurance of containment and included:

Rules and procedures for the review of each test prior to authorization were refined, formalized, codified, and certified.

The group known as the test evaluation panel was reconstituted as the containment evaluation panel and its membership was expanded to include a geologist and hydrologist.

A specific program of investigation and research was implemented with respect to geologic and geophysical characteristics of test emplacements. In particular, containment criteria were analyzed and reconfirmed or replaced, and a greater range of scientific expertise was added to the design, evaluation, and authorization channels.

Finally, during tests, controlled areas within the Nevada test site were expanded and forward area personnel and facilities were restricted to those essential to conducting the test.

The total investigative effort required about 2 months to complete after which action was initiated to obtain Presidential approval for continuation of the program. Testing after Baneberry was resumed in June 1971.

Since the diagonal line event on November 24, 1971, implementation of these required actions has resulted in there being no releases of radioactivity as a result of a test detonation.

As I stated earlier, all weapon testing operations since 1963 have been conducted underground and have been under the exclusive control of the Atomic Energy Commission, later the Energy Research and Development Administration, and now the Department of Energy. Overall policy for the safe conduct of testing is established in DOE Headquarters in Washington. The responsibility for carrying out this policy has been delegated to the manager of the Nevada operations office. While the DOD has been a user of the NTS facilities for effects tests since 1963, they have followed established policy for test operations.

All tests are approved by the President on a semiannual bais. In seeking that Presidential approval, assurances are given that tests will be conducted only if they have been designed to be safely contained and only if they will comply with all U.S. treaty obligations, and with the National Environmental Policy Act.

To insure compliance with these rules, each containment design is carefully reviewed by the sponsoring laboratory before being submitted for review by a group known as the containment evaluation panel. This panel of scientists, experienced in various aspects of the phenomenology of containment, reviews each test, and each member submits an individual evaluation of the soundness of the containment design to the manager of the Nevada operations office. If the manager approves the containment plans, he requests detonation authority from headquarters. At headquarters a final review of the manager's recommendations, the containment evaluation, and other programmatic considerations are made before granting detonation authority. No test is conducted without both Presidential approval, and a thorough containment review.

Once detonation authority is granted to the manager of the Nevada operations office, he may proceed with the final preparations for the test. The actual conduct of the test is under the control of the manager's delegated representative, now called the test controller, formerly the test manager. The test controller is assisted by a scientific advisor who is a senior scientist from the sponsoring weapons laboratory and by a panel to review both onsite and offsite safety considerations. This panel includes three advisers; one from the Environmental Protection Agency; one from the National Weather Service Nuclear Support Office, and one a physician skilled in radiation medicine.

It is unlikely that another major venting will occur. Nevertheless, an evaluation is made of the weather and of the offsite population conditions before a decision is made to proceed. To assist the test controller in his decision, a special branch of the National Weather Service, with both local and national weather prediction capability, makes an analysis of weather conditions and calculates the onsite and offsite fallout patterns based upon a hypothetical venting. This information is used by the test controller and his advisory panel to evaluate procedures for controlling exposures or carrying out emergency plans. If such evaluation indicates that individuals in the onsite or offsite population could receive doses in excess of established guidelines, then the test is postponed until more favorable conditions prevail.

At this point I would like to emphasize that, since 1966, our records show that no one in either the onsite of offsite population has received a dose in excess of the established radiation guidelines from weapons test operations.

A number or the questions relayed to the Department of Energy by the committee staff dealt with leukemia incidence reported by Dr. Caldwell of the Center for Disease Control for individuals who were involved as troop participants in the Department of Defense Desert Rock exercise during the Smoky test in 1957. While the troops involved in the Desert Rock exercises were the responsibility of the military, the Department of Energy recognizes a responsibility to address the question as to whether radiation exposure during the tests might have been the cause of injury.

Thus, in addition to the work undertaken by Dr. Caldwell, much broader study may be needed to obtain statistically reliable information in this regard. As an initial step, the Department of Defense and the Department of Energy have recommended that an independent study be conducted by the National Academy of Sciences of the health status of a few different troop participant populations present for tests at different times.

We believe it desirable that both Dr. Caldwell's survey and the recommended National Academy study proceed in parallel. If the results of these efforts suggest a probably adverse health effect relationship, a decision will be made as to what further steps will have to be taken.

Meanwhile, the Department of Energy data repository currently maintained by REECO in Nevada has been examined, and the DOE has funded a program to improve the capability of the REECO system to store and to provide better access to information that is needed, so that the related exposure questions may be pursued.

Mr. Chairman, that completes my prepared statement. My colleagues and I will be happy to try and answer your questions.

[Testimony resumes on p. 406.]

[The attachments to Dr. Kerr's prepared statement follow:]

ANNOUNCED UNITED STATES NUCLEAR DETONATIONS

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
TRINITY FIRST TEST OF AN A-BOMB	07/16/45	ALAMOGORDO	TOWER	WEAPONS RELATED	19KT
WORLD WAR II FIRST COMBAT USE-HIROSHIMA	08/05/45	JAPAN	AIRDROP	COMBAT	13 KT
WORLD WAR II SECOND COMBAT USE-NAGASAKI	08/09/45	JAPAN	AIRDROP	COMBAT	23 KT
		CROSSROADS			
ABLE	06/30/46	BIKINI	AIRDROP	WEAPONS RELATED	23 KT
BAKER	07/24/46	BIKINI	UW	WEAPONS RELATED	23 KT
		SANDSTONE			
X-RAY	04/14/48	ENIWETOK	TOWER	WEAPONS RELATED	37KT
YOKE	04/30/48	ENIWETOK	TOWER	WEAPONS RELATED	49KT
ZEBRA	05/14/48	ENIWETOK	TOWER	WEAPONS RELATED	18KT
		RANGER			
ABLE	01/27/51	NTS	AIRDROP	WEAPONS RELATED	1KT
BAKER	01/28/51	NTS	AIRDROP	WEAPONS RELATED	8KT
EASY	02/01/51	NTS	AIRDROP	WEAPONS RELATED	1KT
BAKER-2	02/02/51	NTS	AIRDROP	WEAPONS RELATED	8KT
FOX	02/06/51	NTS	AIRDROP	WEAPONS RELATED	22KT
		GREENHOUSE			
DOG	04/07/51	ENIWETOK	TOWER	WEAPONS RELATED	
EASY	04/20/51	ENIWETOK	TOWER	WEAPONS RELATED	47KT
GEORGE	05/08/51	ENIWETOK	TOWER	WEAPONS RELATED	
ITEM	05/24/51	ENIWETOK	TOWER	WEAPONS RELATED	
		BUSTER-JANGLE			
ABLE	10/22/51	NTS	TOWER	WEAPONS RELATED	LESS THAN 0.1KT
BAKER	10/28/51	NTS	AIRDROP	WEAPONS RELATED	3.5KT
CHARLIE	10/30/51	NTS	AIRDROP	WEAPONS RELATED	14KT
DOG	11/01/51	NTS	AIRDROP	WEAPONS RELATED	21KT
EASY	11/05/51	NTS	AIRDROP	WEAPONS RELATED	31KT
SUGAR	11/19/51	NTS	SURFACE	WEAPONS RELATED	1.2KT

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
UNCLE	11/29/51	NTS	CRATER	WEAPONS RELATED	1.2KT
		TUMBLER-SNAPPER			
ABLE	04/01/52	NTS	AIRDROP	WEAPONS RELATED	1KT
BAKER	04/15/52	NTS	AIRDROP	WEAPONS RELATED	1KT
CHARLIE	04/22/52	NTS	AIRDROP	WEAPONS RELATED	31KT
DOG	05/01/52	NTS	AIRDROP	WEAPONS RELATED	19KT
EASY	05/07/52	NTS	TOWER	WEAPONS RELATED	12KT
FOX	05/25/52	NTS	TOWER	WEAPONS RELATED	11KT
GEORGE	06/01/52	NTS	TOWER	WEAPONS RELATED	15KT
HOW	06/05/52	NTS	TOWER	WEAPONS RELATED	14KT
		IVY			
MIKE	10/31/52	ENIWETOK	SURFACE	WEAPONS RELATED	10.4MT
EXPERIMENTAL THERMONUCLEAR DEVICE					
KING	11/15/52	ENIWETOK	AIRDROP	WEAPONS RELATED	500 KT
		UPSHOT-KNOTHOLE			
ANNIE	03/17/53	NTS	TOWER	WEAPONS RELATED	16KT
NANCY	03/24/53	NTS	TOWER	WEAPONS RELATED	24KT
RUTH	03/31/53	NTS	TOWER	WEAPONS RELATED	0.2KT
DIXIE	04/06/53	NTS	AIRDROP	WEAPONS RELATED	11KT
RAY	04/11/53	NTS	TOWER	WEAPONS RELATED	0.2KT
BADGER	04/18/53	NTS	TOWER	WEAPONS RELATED	23KT
SIMON	04/25/53	NTS	TOWER	WEAPONS RELATED	43KT
ENCORE	05/08/53	NTS	AIRDROP	WEAPONS RELATED	27KT
HARRY	05/19/53	NTS	TOWER	WEAPONS RELATED	32KT
GRABLE	05/25/53	NTS	GUN	WEAPONS RELATED	15KT
FIRED FROM 280MM GUN					
CLIMAX	06/04/53	NTS	AIRDROP	WEAPONS RELATED	61KT
		CASTLE			
BRAVO	02/28/54	BIKINI	SURFACE	WEAPONS RELATED	15MT
EXPERIMENTAL THERMONUCLEAR DEVICE					

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
ROMEO	03/26/54	BIKINI	BARGE	WEAPONS RELATED	
KOON	04/06/54	BIKINI	SURFACE	WEAPONS RELATED	110 KT
UNION	04/25/54	BIKINI	BARGE	WEAPONS RELATED	
YANKEE	05/04/54	BIKINI	BARGE	WEAPONS RELATED	
NECTAR	05/13/54	ENIWETOK	BARGE	WEAPONS RELATED	
		TEAPOT			
WASP	02/18/55	NTS	AIRDROP	WEAPONS RELATED	1KT
MOTH	02/22/55	NTS	TOWER	WEAPONS RELATED	2KT
TESLA	03/01/55	NTS	TOWER	WEAPONS RELATED	7KT
TURK	03/07/55	NTS	TOWER	WEAPONS RELATED	43KT
HORNET	03/12/55	NTS	TOWER	WEAPONS RELATED	4KT
BEE	03/22/55	NTS	TOWER	WEAPONS RELATED	8KT
ESS	03/23/55	NTS	CRATER	WEAPONS RELATED	1KT
APPLE-1	03/29/55	NTS	TOWER	WEAPONS RELATED	14KT
WASP PRIME	03/29/55	NTS	AIRDROP	WEAPONS RELATED	3KT
HA	04/06/55	NTS	AIRDROP	WEAPONS RELATED	3KT
POST	04/09/55	NTS	TOWER	WEAPONS RELATED	2KT
MET	04/15/55	NTS	TOWER	WEAPONS RELATED	22KT
APPLE-2	05/05/55	NTS	TOWER	WEAPONS RELATED	29KT
ZUCCHINI	05/15/55	NTS	TOWER	WEAPONS RELATED	28KT
		WIGWAM			
WIGWAM 29 DEGREESN-126 DEGREES W	05/14/55		UW	WEAPONS RELATED	30KT
		REDWING			
LACROSSE	05/04/56	ENIWETOK	SURFACE	WEAPONS RELATED	40 KT
CHEROKEE FIRST AIR DROP BY U.S. OF A THERMONUCLEAR WEAPON	05/20/56	BIKINI	AIRDROP	WEAPONS RELATED	SEVERAL MT
ZUNI	05/27/56	BIKINI	SURFACE	WEAPONS RELATED	3.5 MT
YUMA	05/27/56	ENIWETOK		WEAPONS RELATED	

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
ERIE	05/30/56	ENIWETOK	TOWER	WEAPONS RELATED	
SEMINOLE	06/06/56	ENIWETOK	SURFACE	WEAPONS RELATED	
FLATHEAD	06/11/56	BIKINI	BARGE	WEAPONS RELATED	
BLACKFOOT	06/11/56	ENIWETOK	TOWER	WEAPONS RELATED	
KICKAPOO	06/13/56	ENIWETOK		WEAPONS RELATED	
OSAGE	06/16/56	ENIWETOK	AIRDROP	WEAPONS RELATED	
INCA	06/21/56	ENIWETOK		WEAPONS RELATED	
DAKOTA	06/25/56	BIKINI	BARGE	WEAPONS RELATED	
MOHAWK	07/02/56	ENIWETOK		WEAPONS RELATED	
APACHE	07/08/56	ENIWETOK	BARGE	WEAPONS RELATED	
NAVAJO	07/10/56	BIKINI	BARGE	WEAPONS RELATED	
TEWA	07/20/56	BIKINI	BARGE	WEAPONS RELATED	5 MT
HURON	07/21/56	ENIWETOK	BARGE	WEAPONS RELATED	
		PLUMBBOB			
BOLTZMAN	05/28/57	NTS	TOWER	WEAPONS RELATED	12KT
FRANKLIN	06/02/57	NTS	TOWER	WEAPONS RELATED	140TONS
LASSEN	06/05/57	NTS	BALLOON	WEAPONS RELATED	0.5 TONS
WILSON	06/18/57	NTS	BALLOON	WEAPONS RELATED	10KT
PRISCILLA	06/24/57	NTS	BALLOON	WEAPONS RELATED	37KT
HOOD	07/05/57	NTS	BALLOON	WEAPONS RELATED	74KT
DIABLO	07/15/57	NTS	TOWER	WEAPONS RELATED	17KT
JOHN	07/19/57	NTS	ROCKET	WEAPONS RELATED	ABOUT 2KT
KEPLER	07/24/57	NTS	TOWER	WEAPONS RELATED	10KT
OWENS	07/25/57	NTS	BALLOON	WEAPONS RELATED	9.7KT
STOKES	08/07/57	NTS	BALLOON	WEAPONS RELATED	19KT
SHASTA	08/18/57	NTS	TOWER	WEAPONS RELATED	17KT
DOPPLER	08/23/57	NTS	BALLOON	WEAPONS RELATED	11KT

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
FRANKLIN PRIME	08/30/57	NTS	BALLOON	WEAPONS RELATED	4.7KT
SMOKY	08/31/57	NTS	TOWER	WEAPONS RELATED	44KT
GALILEO	09/02/57	NTS	TOWER	WEAPONS RELATED	11KT
WHEELER	09/06/57	NTS	BALLOON	WEAPONS RELATED	197 TONS
LAPLACE	09/08/57	NTS	BALLOON	WEAPONS RELATED	1KT
FIZEAU	09/14/57	NTS	TOWER	WEAPONS RELATED	11KT
NEWTON	09/16/57	NTS 65	BALLOON	WEAPONS RELATED	12KT
RAINIER FIRST TUNNEL EMPLACEMENT	09/19/57	NTS	TUNNEL	WEAPONS RELATED	1.7KT
WHITNEY	09/23/57	NTS	TOWER	WEAPONS RELATED	19KT
CHARLESTON	09/28/57	NTS	BALLOON	WEAPONS RELATED	12KT
MORGAN	10/07/57	NTS	BALLOON	WEAPONS RELATED	8KT
		HARDTACK			
YUCCA 12 DEGREES 37 MIN N-163 DEGREES 01 MIN E	04/28/58		BALLOON	WEAPONS RELATED	
CACTUS	05/05/58	ENIWETOK	SURFACE	WEAPONS RELATED	18 KT
FIR	05/11/58	BIKINI	BARGE	WEAPONS RELATED	
BUTTERNUT	05/11/58	ENIWETOK	BARGE	WEAPONS RELATED	
KOA	05/12/58	ENIWETOK	SURFACE	WEAPONS RELATED	1.37 MT
WAHOO	05/16/58	ENIWETOK	UW	WEAPONS RELATED	
HOLLY	05/20/58	ENIWETOK	BARGE	WEAPONS RELATED	
NUTMEG	05/21/58	BIKINI	BARGE	WEAPONS RELATED	
YELLOWWOOD	05/26/58	ENIWETOK	BARGE	WEAPONS RELATED	
MAGNOLIA	05/26/58	ENIWETOK	BARGE	WEAPONS RELATED	
TOBACCO	05/30/58	ENIWETOK	BARGE	WEAPONS RELATED	
SYCAMORE	05/31/58	BIKINI	BARGE	WEAPONS RELATED	
ROSE	06/02/58	ENIWETOK	BARGE	WEAPONS RELATED	
UMBRELLA	06/08/58	ENIWETOK	UW	WEAPONS RELATED	

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
MAPLE	06/10/58	BIKINI	BARGE	WEAPONS RELATED	
ASPEN	06/14/58	BIKINI	BARGE	WEAPONS RELATED	
WALNUT	06/14/58	ENIWETOK	BARGE	WEAPONS RELATED	
LINDEN	06/18/58	ENIWETOK	BARGE	WEAPONS RELATED	
REDWOOD	06/27/58	BIKINI	BARGE	WEAPONS RELATED	
ELDER	06/27/58	ENIWETOK	BARGE	WEAPONS RELATED	
OAK	06/28/58	ENIWETOK	BARGE	WEAPONS RELATED	8.9 MT
HICKORY	06/29/58	BIKINI	BARGE	WEAPONS RELATED	
SEQUOIA	07/01/58	ENIWETOK	BARGE	WEAPONS RELATED	
CEDAR	07/02/58	BIKINI	BARGE	WEAPONS RELATED	
DOGWOOD	07/05/58	ENIWETOK	BARGE	WEAPONS RELATED	
POPLAR	07/12/58	BIKINI	BARGE	WEAPONS RELATED	
PISONIA	07/17/58	ENIWETOK		WEAPONS RELATED	
JUNIPER	07/22/58	BIKINI	BARGE	WEAPONS RELATED	
OLIVE	07/22/58	ENIWETOK	BARGE	WEAPONS RELATED	
PINE	07/26/58	ENIWETOK	BARGE	WEAPONS RELATED	
TEAK	08/01/58	JOHNSTON ISL AREA	ROCKET	WEAPONS RELATED	MEGATON RANGE
QUINCE	08/06/58	ENIWETOK		WEAPONS RELATED	
ORANGE	08/12/58	JOHNSTON ISL AREA	ROCKET	WEAPONS RELATED	MEGATON RANGE
FIG	08/18/58	ENIWETOK		WEAPONS RELATED	
		ARGUS			
ARGUS I ABOUT 300 MILES ALTITUDE	08/27/58	SOUTH ATLANTIC	ROCKET	WEAPONS RELATED	1-2KT
ARGUS II ABOUT 300 MILES ALTITUDE	08/30/58	SOUTH ATLANTIC	ROCKET	WEAPONS RELATED	1-2KT
ARGUS III ABOUT 300 MILES ALTITUDE	09/06/58	SOUTH ATLANTIC	ROCKET	WEAPONS RELATED	1-2KT
		HARDTACK			
EDDY	09/19/58	NTS 69	BALLOON	WEAPONS RELATED	83 TONS

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
MORA	09/29/58	NTS ?	BALLOON	WEAPONS RELATED	2KT
TAMALPAIS	10/08/58	NTS	TUNNEL	WEAPONS RELATED	72 TONS
SLIGHT VENTING					
QUAY	10/10/58	NTS	TOWER	WEAPONS RELATED	79 TONS
LEA	10/13/58	NTS	BALLOON	WEAPONS RELATED	1.4KT
HAMILTON	10/15/58	NTS	TOWER	WEAPONS RELATED	1.2 TONS
LOGAN	10/16/58	NTS	TUNNEL	WEAPONS RELATED	5KT
DONA ANA	10/16/58	NTS	BALLOON	WEAPONS RELATED	37 TONS
RIO ARRIBA	10/18/58	NTS	TOWER	WEAPONS RELATED	90 TONS
SOCORRO	10/22/58	NTS	BALLOON	WEAPONS RELATED	6KT
WRANGELL	10/22/58	NTS	BALLOON	WEAPONS RELATED	115 TONS
RUSHMORE	10/22/58	NTS	BALLOON	WEAPONS RELATED	188 TONS
SANFORD	10/26/58	NTS	BALLOON	WEAPONS RELATED	4.9KT
DE BACA	10/26/58	NTS 40	BALLOON	WEAPONS RELATED	2.2KT
EVANS	10/29/58	NTS	TUNNEL	WEAPONS RELATED	55 TONS
VENTING					
HUMBOLDT	10/29/58	NTS 41	TOWER	WEAPONS RELATED	7.8 TONS
SANTA FE	10/30/58	NTS 42	BALLOON	WEAPONS RELATED	1.3KT
BLANCA	10/30/58	NTS	TUNNEL	WEAPONS RELATED	19KT
SLIGHT VENTING					
		NOUGAT			
ANTLER	09/15/61	NTS	TUNNEL	WEAPONS RELATED	2.6KT
SHREW	09/16/61	NTS	SHAFT	WEAPONS RELATED	LOW
LOW YIELD MEANS LESS THAN 20KT					
CHENA	10/10/61	NTS	TUNNEL	WEAPONS RELATED	LOW
MINK	10/29/61	NTS	SHAFT	WEAPONS RELATED	LOW
FISHER	12/03/61	NTS	SHAFT	WEAPONS RELATED	13.5KT
GNOME	12/10/61	CARLSBAD	SHAFT	PLOWSHARE	3.1KT
MULTIPLE-PURPOSE EXPERIMENT IN SALT.FORMED CAVITY 160-170 FT.DIAMETER 60-80 FT.HIGH					

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
MAD	12/13/61	NTS	SHAFT	WEAPONS RELATED	0.43KT
RINGTAIL	12/17/61	NTS	SHAFT	WEAPONS RELATED	LOW
FEATHER	12/22/61	NTS	TUNNEL	WEAPONS RELATED	LOW
STOAT	01/09/62	NTS	SHAFT	WEAPONS RELATED	4.5KT
AGOUTI	01/18/62	NTS	SHAFT	WEAPONS RELATED	5.9KT
DORMOUSE	01/30/62	NTS	SHAFT	WEAPONS RELATED	LOW
STILLWATER	02/08/62	NTS	SHAFT	WEAPONS RELATED	2.7KT
ARMADILLO	02/09/62	NTS	SHAFT	WEAPONS RELATED	6.6KT
HARDHAT GRANITE	02/15/62	NTS	SHAFT	WEAPONS RELATED	5.9KT
CHINCHILLA	02/19/62	NTS	SHAFT	WEAPONS RELATED	1.8KT
CODSAW	02/19/62	NTS	SHAFT	WEAPONS RELATED	LOW
CIMARRON	02/23/62	NTS	SHAFT	WEAPONS RELATED	11.2KT
PLATYPUS	02/24/62	NTS	SHAFT	WEAPONS RELATED	LOW
PAMPAS	03/01/62	NTS	SHAFT	JOINT US-UK	LOW
DANNY BOY	03/05/62	NTS	CRATER	WEAPONS RELATED	0.42KT
CRATER DIAMETER 265 FT. DEPTH 84 FT. IN BASALT					
ERMINE	03/06/62	NTS	SHAFT	WEAPONS RELATED	LOW
BRAZOS	03/08/62	NTS	SHAFT	WEAPONS RELATED	7.6KT
HOGNOSE	03/15/62	NTS	SHAFT	WEAPONS RELATED	LOW
HOOSIC	03/28/62	NTS	SHAFT	WEAPONS RELATED	3KT
CHINCHILLA II	03/31/62	NTS	SHAFT	WEAPONS RELATED	LOW
DORMOUSE II	04/05/62	NTS	SHAFT	WEAPONS RELATED	10KT
PASSAIC	04/06/62	NTS	SHAFT	WEAPONS RELATED	LOW
HUDSON	04/12/62	NTS	SHAFT	WEAPONS RELATED	LOW
PLATTE	04/14/62	NTS	TUNNEL	WEAPONS RELATED	1.7KT
DEAD	04/21/62	NTS	SHAFT	WEAPONS RELATED	LOW
1962 PACIFIC TESTS WERE DESIGNATED DOMINIC I.					

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
ADOBE	04/25/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE
INTERMEDIATE MEANS 20 TO 1000 KT					
AZTEC	04/27/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE
BLACK	04/27/62	NTS	SHAFT	WEAPONS RELATED	LOW
ARKANSAS	05/02/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	LOW MEGATON
QUESTA	05/04/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE
FRIGATE BIRD	05/06/62	CHRISTMAS ISL AREA	MISSILE	WEAPONS RELATED	
WARHEAD IN MISSILE LAUNCHED FROM POLARIS SUBMARINE					
PACA	05/07/62	NTS	SHAFT	WEAPONS RELATED	LOW
YUKON	05/08/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE
MESILLA	05/09/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE
MUSKEGON	05/11/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE
SWORDFISH	05/11/62	EASTERN PACIFIC	UW	WEAPONS RELATED	LOW
ANTISUBMARINE ROCKET /ASROC/ SYSTEM PROOF TEST					
ENCINO	05/12/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE
AARDVARK	05/12/62	NTS	SHAFT	WEAPONS RELATED	38KT
SWANEE	05/14/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE
EEL	05/19/62	NTS	SHAFT	WEAPONS RELATED	LOW
CHETCO	05/19/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE
WHITE	05/25/62	NTS	SHAFT	WEAPONS RELATED	LOW
TANANA	05/25/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	LOW
NAMBE	05/27/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE
RACCOON	06/01/62	NTS	SHAFT	WEAPONS RELATED	LOW
PACKRAT	06/06/62	NTS	SHAFT	WEAPONS RELATED	LOW
ALMA	06/08/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE
TRUCKEE	06/09/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE
YESO	06/10/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	LOW MEGATON
HARLEM	06/12/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
DES MOINES	06/13/62	NTS	TUNNEL	WEAPONS RELATED	LOW
RINCONADA	06/15/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE
DULCE	06/17/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE
PETIT	06/19/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	LOW
DAMAN I	06/21/62	NTS	SHAFT	WEAPONS RELATED	LOW
OTOWI	06/22/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE
BIGHORN	06/27/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	MEGATON RANGE
HAYMAKER	06/27/62	NTS	SHAFT	WEAPONS RELATED	56KT
MARSHMALLOW DOD EVENT	06/28/62	NTS	TUNNEL	WEAPONS RELATED	LOW
BLUESTONE	06/30/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	LOW MEGATON
SACRAMENTO	06/30/62	NTS STORAX	SHAFT	WEAPONS RELATED	LOW
SEDAN EXCAVATION EXPERIMENT-CRATER 1280 FT.DIAM 320 FT.DEEP-THERMONUCLEAR DEV.	07/06/62	NTS	CRATER	PLOWSHARE	100KT
LITTLE FELLERII SLIGHTLY ABOVE GROUND. DOMINIC II SERIES.	07/07/62	NTS 43	SURFACE	WEAPONS RELATED	LOW
STARFISH PRIME HIGH ALTITUDE-450 KM	07/09/62	JOHNSTON ISL AREA	ROCKET	WEAPONS RELATED	1.4 MEGATONS
SUNSET	07/10/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE
PAMLICO	07/11/62	CHRISTMAS ISL AREA	AIRDROP	WEAPONS RELATED	LOW MEGATON
JOHNNY BOY SLIGHTLY ABOVE GROUND. DOMINIC II SERIES.	07/11/62	NTS 44	SURFACE	WEAPONS RELATED	0.5
MERRIMAC	07/13/62	NTS	SHAFT	WEAPONS RELATED	LOW
SMALL BOY SLIGHTLY ABOVE GROUND. DOMINIC II SERIES.	07/14/62	NTS 45	SURFACE	WEAPONS RELATED	LOW
LITTLE FELLER I TROOP PARTICIPATION. SLIGHTLY ABOVE GROUND. DOMINIC II SERIES.	07/17/62	NTS 46	SURFACE	WEAPONS RELATED	LOW
WICHITA	07/27/62	NTS	SHAFT	WEAPONS RELATED	LOW
YORK	08/24/62	NTS	SHAFT	WEAPONS RELATED	LOW
BOBAC	08/24/62	NTS	SHAFT	WEAPONS RELATED	LOW

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
HYRAX	09/14/62	NTS	SHAFT	WEAPONS RELATED	LOW
PEBA	09/20/62	NTS	SHAFT	WEAPONS RELATED	LOW
ALLEGHENY	09/29/62	NTS	SHAFT	WEAPONS RELATED	LOW
ANDROSCOGGIN	10/02/62	JOHNSTON ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE
MISSISSIPPI	10/05/62	NTS	SHAFT	WEAPONS RELATED	110 KT
BUMPING	10/06/62	JOHNSTON ISL AREA	AIRDROP	WEAPONS RELATED	LOW
ROANOKE	10/12/62	NTS	SHAFT	WEAPONS RELATED	LOW
CHAMA	10/18/62	JOHNSTON ISL AREA	AIRDROP	WEAPONS RELATED	LOW MEGATON
BANDICOOT	10/19/62	NTS	SHAFT	WEAPONS RELATED	LOW
CHECKMATE HIGH ALTITUDE - TENS OF KMS	10/20/62	JOHNSTON ISL AREA	ROCKET	WEAPONS RELATED	LOW
BLUEGILL 3PRIME HIGH ALTITUDE - TENS OF KMS	10/26/62	JOHNSTON ISL AREA	ROCKET	WEAPONS RELATED	SUBMEGATON
SANTEE	10/27/62	NTS	SHAFT	WEAPONS RELATED	LOW
CALAMITY	10/27/62	JOHNSTON ISL AREA	AIRDROP	WEAPONS RELATED	INTERMEDIATE
HOUSATONIC	10/30/62	JOHNSTON ISL AREA	AIRDROP	WEAPONS RELATED	MEGATON RANGE
KINGFISH HIGH ALTITUDE - TENS OF KMS	11/01/62	JOHNSTON ISL AREA	ROCKET	WEAPONS RELATED	SUBMEGATON
TIGHTROPE HIGH ALTITUDE - TENS OF KMS	11/04/62	JOHNSTON ISL AREA	ROCKET	WEAPONS RELATED	LOW
ANACOSTIA DEVICE DEVELOPMENT	11/27/62	NTS	SHAFT	PLOWSHARE	LOW
TENDRAC	12/07/62	NTS	SHAFT	JOINT US-UK	LOW
MADISON	12/12/62	NTS	TUNNEL	WEAPONS RELATED	LOW
NUMBAT	12/12/62	NTS	SHAFT	WEAPONS RELATED	LOW
CASSELMAN	02/08/63	NTS	SHAFT	WEAPONS RELATED	INTERMEDIATE
ACUSHI	02/08/63	NTS	SHAFT	WEAPONS RELATED	INTERMEDIATE
KAWEAH DEVICE DEVELOPMENT	02/21/63	NTS	SHAFT	PLOWSHARE	LOW
CARMEL	02/21/63	NTS	SHAFT	WEAPONS RELATED	LOW

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
GERBIL	03/29/63	NTS	SHAFT	WEAPONS RELATED	LOW
FERRET PRIME	04/05/63	NTS	SHAFT	WEAPONS RELATED	LOW
STONES	05/22/63	NTS	SHAFT	WEAPONS RELATED	INTERMEDIATE
YUBA	06/05/63	NTS	SHAFT	WEAPONS RELATED	LOW
HUTIA	06/06/63	NTS	SHAFT	WEAPONS RELATED	LOW
MATACO	06/14/63	NTS	SHAFT	WEAPONS RELATED	LOW
KENNEBEC	06/25/63	NTS NIBLICK	SHAFT	WEAPONS RELATED	LOW
PEKAN	08/12/63	NTS	SHAFT	WEAPONS RELATED	LOW
SATSOP	08/15/63	NTS	SHAFT	WEAPONS RELATED	LOW
UNNAMED 1	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 2	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 3	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 4	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 5	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 6	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 7	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 8	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 9	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 10	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 11	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 12	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 13	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 14	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 15	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 16	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 17	00/00/00	NTS		WEAPONS RELATED	

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
UNNAMED 18	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 19	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 20	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 21	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 22	00/00/00	NTS		WEAPONS RELATED	
UNNAMED 23	00/00/00	NTS		WEAPONS RELATED	
ANNOUNCED AS HAVING BEEN CONDUCTED BETWEEN 09/15/61 AND 08/20/63 NO OTHER DATA AVAILABLE FOR PUBLIC USE.					
KOHOCTON	08/23/63	NTS	SHAFT	WEAPONS RELATED	LOW
AHTANUM	09/13/63	NTS	SHAFT	WEAPONS RELATED	LOW
BILBY	09/13/63	NTS	SHAFT	WEAPONS RELATED	ABOUT 200KT
FIRST UNDERGROUND TEST REPORTED FELT IN LAS VEGAS					
GRUNION	10/11/63	NTS	SHAFT	WEAPONS RELATED	LOW
TORNILLO	10/11/63	NTS	SHAFT	PLOWSHARE	LOW
DEVICE DEVELOPMENT					
CLEARWATER	10/16/63	NTS	SHAFT	WEAPONS RELATED	INTERMEDIATE
SHOAL	10/26/63	FALLON	SHAFT	VELA UNIFORM	ABOUT 12KT
NUCLEAR TEST DETECTION-RESEARCH EXPERIMENT NEAR FALLON NEVADA					
ANCHOVY	11/14/63	NTS	SHAFT	WEAPONS RELATED	LOW
MUSTANG	11/15/63	NTS	SHAFT	WEAPONS RELATED	LOW
GREYS	11/22/63	NTS	SHAFT	WEAPONS RELATED	LOW
SARDINE	12/04/63	NTS	SHAFT	WEAPONS RELATED	LOW
EAGLE	12/12/63	NTS	SHAFT	WEAPONS RELATED	LOW
MINOR LEVELS OF RADIOACTIVITY DETECTED OFFSITE 1					
FORE	01/16/64	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
OCONTO	01/23/64	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
KLICKITAT	02/20/64	NTS	SHAFT	PLOWSHARE	20 TO 200KT
DEVICE DEVELOPMENT					
PIKE	03/13/64	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
MINOR LEVELS OF RADIOACTIVITY DETECTED OFFSITE 2					
HOOK	04/14/64	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
STURGEON	04/15/64	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
TURF	04/24/64	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
PIPEFISH	04/29/64	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
BACKSWING	05/14/64	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
MINNOW	05/15/64	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
ACE	06/11/64	NTS	SHAFT	PLOWSHARE	LESS THAN 20KT
DEVICE DEVELOPMENT					
FADE	06/25/64	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
DUB	06/30/64	NTS	SHAFT	PLOWSHARE	LESS THAN 20KT
DEVICE DEVELOPMENT					
		WHETSTONE			
RYE	07/16/64	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
CORMORANT	07/17/64	NTS	SHAFT	JOINT US-UK	LESS THAN 20KT
ALVA	08/19/64	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
CANVASBACK	08/22/64	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
HADDOCK	08/28/64	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
GUANAY	09/04/64	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
AUK	10/02/64	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
PAR	10/09/64	NTS	SHAFT	PLOWSHARE	38KT
ISOTOPE PRODUCTION-EXPLOSIVE DEVELOPMENT					
BARBEL	10/16/64	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
SALMON	10/22/64	HATTIESBURG	SHAFT	VELA UNIFORM	5.3KT
NUCLEAR TEST DETECTION RESEARCH EXPERIMENT					
FOREST	10/31/64	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
HANDCAR	11/05/64	NTS	SHAFT	PLOWSHARE	12KT
EFFECTS OF CONTAINED EXPLOSION IN CARBONATE ROCK					
CREPE	12/05/64	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
PARROT	12/16/64	NTS	SHAFT	WEAPONS RELATED	1.2KT
MINOR LEVELS OF RADIOACTIVITY DETECTED OFFSITE 3					
MUDPACK	12/16/64	NTS	SHAFT	WEAPONS RELATED	2.4KT

EVENT NAME DOD EVENT	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
SULKY	12/18/64	NTS	SHAFT	PLOWSHARE	0.092KT
EXCAVATION TEST OF EXPLOSIVE BURIED AT GREATER DEPTH IN RELATION TO YIELD PRODUCED MOUND OF BROKEN ROCK					
WOOL	01/14/65	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
CASHMERE	02/04/65	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
ALPACA	02/12/65	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
MINOR LEVELS OF RADIOACTIVITY DETECTED OFFSITE 4					
MERLIN	02/16/65	NTS	SHAFT	WEAPONS RELATED	10KT
WISH BONE	02/18/65	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
DOD EVENT					
WAGTAIL	03/03/65	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
CUP	03/26/65	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
KESTREL	04/05/65	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
PALANQUIN	04/14/65	NTS PAHUTE	CRATER	PLOWSHARE	4.3KT
CRATERING EXPERIMENT					
GUM DROP	04/21/65	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
DOD EVENT					
TEE	05/07/65	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
MINOR LEVELS OF RADIOACTIVITY DETECTED OFFSITE 5					
BUTEO	05/12/65	NTS PAHUTE	SHAFT	WEAPONS RELATED	LESS THAN 20KT
SCAUP	05/14/65	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
CAMBRIC	05/14/65	NTS	SHAFT	WEAPONS RELATED	.75KT
TWEED	05/21/65	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
PETREL	06/11/65	NTS	SHAFT	WEAPONS RELATED	1.2KT
DILUTED WATERS	06/16/65	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
DOD EVENT. MINOR LEVELS OF RADIOACTIVITY DETECTED OFFSITE 6					
TINY TOT	06/17/65	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
DOD EVENT					
		FLINTLOCK			
BRONZE	07/23/65	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
MAUVE	08/06/65	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
CENTAUR	08/27/65	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
SCREAMER	09/01/65	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
CHARCOAL	09/10/65	NTS	SHAFT	JOINT US-UK	20 TO 200KT
ELKHART	09/17/65	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
LONG SHOT	10/29/65	AMCHITKA	SHAFT	VELA UNIFORM	ABOUT 80KT
DOD EVENT. NUCLEAR TEST DETECTION EXPERIMENT					
SEPIA	11/12/65	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
CORDUROY	12/03/65	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
EMERSON	12/16/65	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
BUFF	12/16/65	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
MAXWELL	01/13/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
LAMPBLACK	01/18/66	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
DOVEKIE	01/21/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
PLAID II	02/03/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
REX	02/24/66	NTS PAHUTE	SHAFT	WEAPONS RELATED	16KT
RED HOT	03/05/66	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
DOD EVENT. MINOR LEVELS OF RADIOACTIVITY DETECTED OFFSITE 7					
FINFOOT	03/07/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
CLYMER	03/12/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
PURPLE	03/18/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
TEMPLAR	03/24/66	NTS	SHAFT	PLOWSHARE	LESS THAN 20KT
EXCAVATION DEVICE DEVELOPMENT					
LIME	04/01/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
STUTZ	04/06/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
TOMATO	04/07/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
DURYEA	04/14/66	NTS PAHUTE	SHAFT	WEAPONS RELATED	65KT
PIN STRIPE	04/25/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
DOD EVENT. MINOR LEVELS OF RADIOACTIVITY DETECTED OFFSITE 8					
TRAVELLER	05/04/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
CYCLAMEN INCLUDED HEAVY ELEMENT EXPERIMENT	05/05/66	NTS	SHAFT	WEAPONS RELATED	12KT
CHARTREUSE	05/06/66	NTS PAHUTE	SHAFT	WEAPONS RELATED	70KT
TAPESTRY	05/12/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
PIRANHA	05/13/66	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
DUMONT	05/19/66	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
DISCUS THROWER DOD EVENT	05/27/66	NTS	SHAFT	WEAPONS RELATED	21KT
PILE DRIVER DOD EVENT	06/02/66	NTS	TUNNEL	WEAPONS EFFECTS	56 KT
TAN	06/03/66	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
PUCE	06/10/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
DOUBLE PLAY DOD EVENT. MINOR LEVELS 9	06/15/66	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
KANKAKEE	06/15/66	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
VULCAN DEVICE DEVELOPMENT. HEAVY ELEMENT PRODUCTION.	06/25/66	NTS	SHAFT	PLOWSHARE	25KT
HALFBEAK	06/30/66	NTS PAHUTE LATCHKEY	SHAFT	WEAPONS RELATED	300KT
SAXON EXCAVATION DEVICE DEVELOPMENT	07/28/66	NTS	SHAFT	PLOWSHARE	LESS THAN 20KT
ROVENA	08/10/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
DERRINGER MINOR LEVELS OF RADIOACTIVITY DETECTED OFFSITE 10	09/12/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
DAIQUIRI	09/23/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
NEWARK	09/29/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
SIMMS EXCAVATION DEVICE DEVELOPMENT	11/05/66	NTS	SHAFT	PLOWSHARE	LESS THAN 20KT
AJAX	11/11/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
CERISE	11/18/66	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
STERLING	12/03/66	HATTIESBURG	SHAFT	VELA UNIFORM	380 TONS

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
NUCLEAR TEST DETECTION EXPERIMENT					
NEW POINT	12/13/66	NTS	SHAFT	WEAPONS EFFECTS	LESS THAN 20KT
DOD EVENT					
GREELEY	12/20/66	NTS PAHUTE	SHAFT	WEAPONS RELATED	825KT
NASH	01/19/67	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
MINOR LEVELS OF RADIOACTIVITY DETECTED OFFSITE 11					
BOURBON	01/20/67	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
WARD	02/08/67	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
PERSIMMON	02/23/67	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
AGILE	02/23/67	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
RIVET III	03/02/67	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
FAWN	04/07/67	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
CHOCOLATE	04/21/67	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
EFFENDI	04/27/67	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
MICKEY	05/10/67	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
COMMODORE	05/20/67	NTS	SHAFT	WEAPONS RELATED	250 KT
SCOTCH	05/23/67	NTS PAHUTE	SHAFT	WEAPONS RELATED	150KT
KNICKERBOCKER	05/26/67	NTS PAHUTE	SHAFT	WEAPONS RELATED	71KT
SWITCH	06/22/67	NTS	SHAFT	PLOWSHARE	LESS THAN 20KT
EXCAVATION DEVICE DEVELOPMENT					
MIDI MIST	06/26/67	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
DOD EVENT					
UMBER	06/29/67	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
MINOR LEVELS OF RADIOACTIVITY DETECTED OFFSITE 12					
CROSSTIE					
STANLEY	07/27/67	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
WASHER	08/10/67	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
BORDEAUX	08/18/67	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
DOOR MIST	08/31/67	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
DOD EVENT. MINOR LEVELS OF RADIOACTIVITY DETECTED OFFSITE 13					
YARD	09/07/67	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT

358

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
MARVEL	09/21/67	NTS	SHAFT	PLOWSHARE	LESS THAN 20KT
EMPLACEMENT TECHNIQUE EXPERIMENT					
ZAZA	09/27/67	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
LANPHER	10/18/67	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
SAZERAC	10/25/67	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
COBBLER	11/08/67	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
GASBUGGY	12/10/67	FARMINGTON	SHAFT	PLOWSHARE	29KT
JOINT GOVT-INDUSTRY GAS STIMULATION EXPERIMENT					
STILT	12/15/67	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
HUPMOBILE	01/18/68	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
MINOR LEVELS OF RADIOACTIVITY DETECTED OFFSITE 14					
STACCATO	01/19/68	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
FAULTLESS	01/19/68	CENTRAL NEVADA	SHAFT	CALIBRATION	200 TO 1000KT
CABRIOLET	01/26/68	NTS PAHUTE	CRATER	PLOWSHARE	2.3KT
KNOX	02/21/68	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
DORSAL FIN	02/29/68	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
DOD EVENT					
BUGGY	03/12/68	NTS	CRATER	PLOWSHARE	5.4KT
ROW CHARGE EXPERIMENT - FIVE SIMULTANEOUS DETONATIONS					
POMMARD	03/14/68	NTS	SHAFT	WEAPONS RELATED	1.5KT
STINGER	03/22/68	NTS PAHUTE	SHAFT	WEAPONS RELATED	20 TO 200KT
MILK SHAKE	03/25/68	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
DOD EVENT					
NOOR	04/10/68	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
SHUFFLE	04/18/68	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
SCROLL	04/23/68	NTS PAHUTE	SHAFT	VELA UNIFORM	LESS THAN 20KT
NUCLEAR TEST DETECTION EXPERIMENT					
BOXCAR	04/26/68	NTS PAHUTE	SHAFT	WEAPONS RELATED	1.2 MEGATONS
CLARKSMOBILE	05/17/68	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
TUB	06/06/68	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
RICKEY	06/15/68	NTS PAHUTE	SHAFT	WEAPONS RELATED	20 TO 200KT
CHATEAUGAY	06/28/68	NTS PAHUTE BOWLINE	SHAFT	WEAPONS RELATED	20 TO 200KT
TANYA	07/30/68	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
DIANA MOON DOD EVENT	08/27/68	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
SLED	08/29/68	NTS PAHUTE	SHAFT	WEAPONS RELATED	20 TO 200KT
NOGGIN	09/06/68	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
KNIFE A	09/12/68	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
STODDARD EXCAVATION DEVICE DEVELOPMENT	09/17/68	NTS	SHAFT	PLOWSHARE	20 TO 200KT
HUDSON SEAL DOD EVENT	09/24/68	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
KNIFE C	10/03/68	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
CREW	11/04/68	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
KNIFE B	11/15/68	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
MING VASE DOD EVENT AREA 16	11/20/68	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
TINDERBOX	11/22/68	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
SCHOONER	12/08/68	NTS PAHUTE	CRATER	PLOWSHARE	35KT
TYG	12/12/68	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
BENHAM	12/19/68	NTS PAHUTE	SHAFT	WEAPONS RELATED	1.1 MEGATON
PACKARD	01/15/69	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
WINESKIN	01/15/69	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
VISE	01/30/69	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
CYPRESS	02/12/69	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
BARSAC	03/20/69	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
COFFER	03/21/69	NTS	SHAFT	WEAPONS RELATED	LESS THAN 100KT
THISTLE	04/30/69	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
BLENTON	04/30/69	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
PURSE	05/07/69	NTS PAHUTE	SHAFT	WEAPONS RELATED	20 TO 200KT
TORRIDO	05/27/69	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
TAPPER	06/12/69	NTS MANDREL	SHAFT	WEAPONS RELATED	LESS THAN 20KT
ILORIN	07/16/69	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
HUTCH	07/16/69	NTS	SHAFT	WEAPONS RELATED	200 TO 1000KT
SPIDER	08/14/69	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
PLIERS	08/27/69	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
RULISON JOINT GOVT-INDUSTRY GAS STIMULATION EXPERIMENT	09/10/69	GRAND VALLEY	SHAFT	PLOWSHARE	40KT
MINUTE STEAK ODD EVENT	09/12/69	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
JORUM	09/16/69	NTS PAHUTE	SHAFT	WEAPONS RELATED	LESS THAN 1 MEGAT
MILROW	10/02/69	AMCHITKA	SHAFT	CALIBRATION	ABOUT 1 MEGATON
PIPKIN	10/08/69	NTS	SHAFT	WEAPONS RELATED	200 TO 1000KT
CRUET	10/29/69	NTS	SHAFT	WEAPONS RELATED	11 KT
POD MINOR LEVELS OF RADIOACTIVITY DETECTED OFFSITE 15	10/29/69	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
CALABASH	10/29/69	NTS	SHAFT	WEAPONS RELATED	110KT
PICCALILLI	11/21/69	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
DIESEL TRAIN ODD EVENT	12/05/69	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
GRAPE A	12/17/69	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
LOVAGE	12/17/69	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
TERRINE	12/18/69	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
FOB	01/23/70	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
AJO IN MINED SHAFT	01/30/70	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
GRAPE B	02/04/70	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
LABIS	02/05/70	NTS	SHAFT	WEAPONS RELATED	25 KT
DIANA MIST DOD EVENT	02/11/70	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
CUMARIN	02/25/70	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
YANNIGAN	02/26/70	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
CYATHUS	03/06/70	NTS	SHAFT	WEAPONS RELATED	8.7 KT
ARABIS	03/06/70	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
JAL	03/19/70	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
SHAPER	03/23/70	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
HANDLEY	03/26/70	NTS PAHUTE	SHAFT	WEAPONS RELATED	MORE THAN 1 MEGAT
SNUBBER MINOR LEVELS OF RADIOACTVITY DETECTED OFFSITE 16	04/21/70	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
CAN	04/21/70	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
BEEBALM	05/01/70	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
HOD	05/01/70	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
MINT LEAF DOD EVENT RELEASE, [illegible] MINOR LEVELS OF RADIATION OFFSITE 17	05/05/70	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
DIAMOND DUST NUCLEAR TEST DETECTION EXPERIMENT	05/12/70	NTS	TUNNEL	VELA UNIFORM	LESS THAN 20KT
CORNICE	05/15/70	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
MANZANAS	05/21/70	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
MORRONES	05/21/70	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
HUDSON MOON DOD EVENT	05/26/70	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
FLASK	05/26/70	NTS	SHAFT	PLOWSHARE	105KT
ARNICA	06/26/70	NTS EMERY	SHAFT	WEAPONS RELATED	20 TO 200KT
TIJERAS	10/14/70	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
ABEYTAS	11/05/70	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
ARTESIA	12/16/70	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
CREAM	12/16/70	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
CARPETBAG	12/17/70	NTS	SHAFT	WEAPONS RELATED	220KT
BANEBERRY	12/18/70	NTS	SHAFT	WEAPONS RELATED	10 KT
MINOR LEVELS OF RADIOACTIVITY DETECTED OFFSITE 1					
EMBUDO	06/16/71	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
LAGUNA	06/23/71	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
HAREBELL	06/24/71	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
		GROMMET			
DIAMOND MINE	07/01/71	NTS	TUNNEL	VELA UNIFORM	LESS THAN 20KT
NUCLEAR TEST DETECTION EXPERIMENT					
MINIATA	07/08/71	NTS	SHAFT	PLOWSHARE	80 KT
DEVICE DEVELOPMENT EXPERIMENT					
ALGODONES	08/18/71	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
PEDERNAL	09/29/71	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
CATHAY	10/08/71	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
CANNIKIN	11/06/71	AMCHITKA	SHAFT	WEAPONS RELATED	LESS THAN 5 MEGAT
TEST OF WARHEAD FOR SPARTAN MISSILE					
DIAGONAL LINE	11/24/71	NTS	SHAFT	WEAPONS EFFECTS	LESS THAN 20KT
DOD EVENT	MINOR LEVELS OF RADIOACTIVITY DETECTED OFFSITE 1				
CHAENACTIS	12/14/71	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
LONGCHAMPS	04/19/72	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
MISTY NORTH	05/02/72	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
DOD EVENT					
ZINNIA	05/17/72	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
MONERO	05/19/72	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
		TOGGLE			
DIAMOND SCULLS	07/20/72	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
DOD EVENT					
OSCURO	09/21/72	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
DELPHINIUM	09/26/72	NTS	SHAFT	WEAPONS RELATED	15KT
FLAX	12/21/72	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT

EVENT NAME	DATE (GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
MIERA	03/08/73	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
ANGUS	04/25/73	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
STARWORT	04/26/73	NTS	SHAFT	WEAPONS RELATED	85KT
RIO BLANCO GAS STIMULATION EXPERIMENT	05/17/73	RIFLE JOINT GOVT-INDUSTRY	SHAFT	PLOWSHARE	THREE 30KT DEVICE
DIDO QUEEN DOD EVENT	06/05/73	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
ALMENDRO	06/06/73	NTS PAHUTE	SHAFT	WEAPONS RELATED	200 TO 1000KT
PORTULACA	06/28/73	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
		ARBOR			
HUSKY ACE DOD EVENT	10/12/73	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
BERNAL	11/28/73	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
LATIR	02/27/74	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
FALLON	05/23/74	NTS	SHAFT	JOINT US-UK	20 TO 200KT
WING BLADE DOD EVENT	06/19/74	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
		BEDROCK			
ESCABOSA	07/10/74	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
PUYE	08/14/74	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
PORTMANTEAU	08/30/74	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
STANYAN	09/26/74	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
HYBLA FAIR DOD EVENT	10/28/74	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
TOPGALLANT	02/28/75	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
CABRILLO	03/07/75	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
DINING CAR DOD EVENT	04/05/75	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
EDAM	04/24/75	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
OBAR	04/30/75	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
TYBO	05/14/75	NTS PAHUTE	SHAFT	WEAPONS RELATED	200 TO 1000KT

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
STILTON	06/03/75	NTS PAHUTE	SHAFT	WEAPONS RELATED	20 TO 200KT
MIZZEN	06/03/75	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
MAST	06/19/75	NTS PAHUTE	SHAFT	WEAPONS RELATED	200 TO 1000KT
CAMEMBERT	06/26/75	NTS PAHUTE ANVIL	SHAFT	WEAPONS RELATED	200 TO 1000KT
MARSH	09/06/75	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
HUSKY PUP DOD EVENT	10/24/75	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
KASSERI	10/28/75	NTS PAHUTE	SHAFT	WEAPONS RELATED	200 TO 1000KT
INLET	11/20/75	NTS PAHUTE	SHAFT	WEAPONS RELATED	200 TO 1000KT
LEYDEN	11/26/75	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20KT
CHIBERTA	12/20/75	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
MUENSTER	01/03/76	NTS PAHUTE	SHAFT	WEAPONS RELATED	200 TO 1000KT
KEELSON	02/04/76	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
ESROM	02/04/76	NTS	SHAFT	WEAPONS RELATED	20 TO 200KT
FONTINA	02/12/76	NTS PAHUTE	SHAFT	WEAPONS RELATED	200 TO 1000KT
CHESHIRE	02/14/76	NTS PAHUTE	SHAFT	WEAPONS RELATED	200 TO 500KT
ESTUARY	03/09/76	NTS PAHUTE	SHAFT	WEAPONS RELATED	200 TO 500KT
COLBY	03/14/76	NTS PAHUTE	SHAFT	WEAPONS RELATED	500 TO 1000KT
POOL	03/17/76	NTS PAHUTE	SHAFT	WEAPONS RELATED	200 TO 500KT
STRAIT	03/17/76	NTS	SHAFT	WEAPONS RELATED	200 TO 500KT
MIGHTY EPIC DOD EVENT	05/12/76	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20KT
BILLET	07/27/76	NTS	SHAFT	WEAPONS RELATED	20 TO 150 KT
BANON	08/26/76	NTS FULCRUM	SHAFT	JOINT US-UK	20 TO 150 KT
CHEVRE	11/23/76	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20 KT
REDMUD	12/08/76	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20 KT
ASIAGO	12/21/76	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20 KT

EVENT NAME	DATE(GCT)	LOCATION	TYPE	PURPOSE	YIELD RANGE
RUDDER	12/28/76	NTS	SHAFT	WEAPONS RELATED	20 TO 150 KT
MARSILLY	04/05/77	NTS	SHAFT	WEAPONS RELATED	20 TO 150 KT
BULKHEAD	04/27/77	NTS	SHAFT	WEAPONS RELATED	20 TO 150 KT
CREWLINE	05/25/77	NTS	SHAFT	WEAPONS RELATED	20 TO 150 KT
STRAKE	08/04/77	NTS	SHAFT	WEAPONS RELATED	20 TO 150 KT
SCANTLING	08/19/77	NTS	SHAFT	WEAPONS RELATED	20 TO 150 KT
EBBTIDE	09/15/77	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20 KT
COULOMMIERS	09/27/77	NTS	SHAFT	WEAPONS RELATED	20 TO 150 KT
BOBSTAY	10/26/77	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20 KT
HYBLA GOLD	11/01/77	NTS	TUNNEL	WEAPONS EFFECTS	LESS THAN 20 KT
SANDREEF	11/09/77	NTS	SHAFT	WEAPONS RELATED	20 TO 150 KT
SEAMOUNT	11/17/77	NTS	SHAFT	WEAPONS RELATED	LESS THAN 20 KT
FARALLONES	12/14/77	NTS	SHAFT	WEAPONS RELATED	20 TO 150 KT

TOTALS BY YEAR

	U.S.	US/UK
TOTAL CY 1945	3	
TOTAL CY 1946	2	
TOTAL CY 1947		
TOTAL CY 1948	3	
TOTAL CY 1949		
TOTAL CY 1950		
TOTAL CY 1951	16	
TOTAL CY 1952	10	
TOTAL CY 1953	11	
TOTAL CY 1954	6	
TOTAL CY 1955	15	
TOTAL CY 1956	17	
TOTAL CY 1957	24	
TOTAL CY 1958	55	
TOTAL CY 1959		
TOTAL CY 1960		
TOTAL CY 1961	9	
TOTAL CY 1962	88*	2
TOTAL CY 1963	25	
TOTAL CY 1964	28	1
TOTAL CY 1965	28	1
TOTAL CY 1966	40	
TOTAL CY 1967	28	
TOTAL CY 1968	33	
TOTAL CY 1969	28	
TOTAL CY 1970	30	
TOTAL CY 1971	11	
TOTAL CY 1972	8	
TOTAL CY 1973	9	
TOTAL CY 1974	7	1
TOTAL CY 1975	16	
TOTAL CY 1976	15	1
TOTAL CY 1977	12	
TOTAL CY 1978		
TOTAL CY 1979		
TOTAL CY 1980		
TOTAL CY 1981		
TOTAL CY 1982		
TOTAL CY 1983		
TOTAL CY 1984		
TOTAL CY 1985		
TOTAL YR UNKNOWN	23	
GRAND TOTAL	600	6
TOTAL SINCE 8/5/63	307	4

TOTALS BY TYPE

	U.S.	US/UK
TOTAL TUNNEL	38	
TOTAL SHAFT	336	6
TOTAL CRATER	8	
TOTAL UNDERGROUND	382	6
TOTAL BALLOON	24	
TOTAL TOWER	45	
TOTAL AIRDROP	54	
TOTAL ROCKET	11	
TOTAL SURFACE	13	
TOTAL GUN	1	
TOTAL BARGE	34	
TOTAL MISSILE	1	
TOTAL ATMOSPHERIC	183	
NTS "	96	
TOTAL UNDERWATER	5	
TOTAL TYPE UNKNOWN	30	
GRAND TOTAL	600	6

TOTALS BY LOCATION

	U.S.	US/UK
TOTAL PACIFIC		
TOTAL JOHNSTON ISL. AREA	12	
TOTAL EASTERN PACIFIC	1	
TOTAL ENIWETOK	42	
TOTAL BIKINI	23	
TOTAL CHRISTMAS ISL. AREA	25	
TOTAL PACIFIC	103	
TOTAL NTS	444	6
TOTAL NTS PAHUTE	34	
TOTAL NTS	478	6
TOTAL SOUTH ATLANTIC	3	
TOTAL CENTRAL NEVADA	1	
TOTAL AMCHITKA	3	
TOTAL ALAMOGORDO	1	
TOTAL JAPAN	2	
TOTAL CARLSBAD	1	
TOTAL HATTIESBURG	2	
TOTAL FARMINGTON	1	
TOTAL GRAND VALLEY	1	
TOTAL RIFLE	1	
TOTAL FALLON	1	
TOTAL OFF-SITE	14	
TOTAL LOCATION UNKNOWN	2	
GRAND TOTAL	600	6

*ADD ONE TEST IN 1962 ANNOUNCED BY GENERAL STARBIRD AS "A TEST OF A DEVICE USING REACTOR GRADE PLUTONIUM." NO OTHER DATA AVAILABLE FOR PUBLIC USE.

BANEBERRY SUMMARY REPORT

APPENDIX B

TABLE OF CONTENTS

SECTION NO. PAGE

SUMMARY 1

1 DESCRIPTION AND LOCATION OF THE EXPERIMENT 2

2 CONTAINMENT ANALYSIS 2

- 2.1 Shot-Time Phenomena 2
- 2.2 Yield and Energy Coupling 3
  - 2.2.1 Radiochemical Analysis 3
  - 2.2.2 Seismic Measurements 3
- 2.3 Hole History 4
- 2.4 Stemming Emplacement 5
- 2.5 Geology of the BANEBERRY Site 5
- 2.6 BANEBERRY LOS Containment Diagnostics 6
- 2.7 Conclusions 7

3 RADIOLOGICAL SAFETY ACTIVITIES 7

- 3.1 Control Point Operations 7
- 3.2 Onsite Radiological Safety Activities 8
  - 3.2.1 Personnel Radiological Surveys 8
  - 3.2.2 Onsite Doses to Persons 8
  - 3.2.3 Equipment Decontamination 8
  - 3.2.4 Areal Radiation Surveys and Decontamination 11
- 3.3 Offsite Radiological Safety Activities 11
  - 3.3.1 External Exposure 11
  - 3.3.2 Ingestion Doses 12
  - 3.3.3 Inhalation Doses 15
  - 3.3.4 Cooperative LRL-University of Utah Radioecological Studies 15
- 3.4 Conclusions 15

SUMMARY

The BANEBERRY underground nuclear device development test of less than 20 kilotons was detonated near the northern border of Yucca Flat on the Nevada Test Site (NTS) at 7:30 a.m., PST, on December 18, 1970. All programmed operations proceeded normally until 3.5 minutes after detonation when a release of radioactivity commenced from a fissure which opened up after detonation at a distance of about 300 feet and in a southwesterly direction from the emplacement hole. This release continued over an extended period even after commonly experienced surface collapse occurred at 16.5 minutes after detonation. This collapse was a normal and expected phenomenon. The effluent venting rate steadily decreased with time but visible vapor continued to emanate from the fissure for 24 hours after detonation.

Because the phenomena which led to release of radioactivity from the BANEBERRY test were not immediately evident, the Commission suspended weapons tests at the NTS until it had reviewed BANEBERRY in detail and was convinced that every reasonable precaution was initiated to minimize the probability of a similar future occurrence. This report is a summary of the events surrounding the BANEBERRY release and postshot investigative findings and conclusions.

The BANEBERRY venting can be attributed basically to stronger coupling of energy into the ground than is normal for tests buried at this depth in Yucca Flat. This stronger coupling was due to a high water content at shallow depth which resulted from a geologic environment unique in test experience and limited to a relatively small area around the BANEBERRY site. The emplacement geometry and other geologic characteristics of the surrounding media may have contributed in a lesser degree to the release.

Radioactivity released as a result of the BANEBERRY detonation produced some exposures to personnel both onsite and offsite However, operational safety procedures instituted following the detonation were successful in ensuring that radiation exposures to test site workers or the offsite population were below currently established Federal Radiation Council standards for normal peacetime operations. Section 3 of this report reviews radiological safety activities associated with BANEBERRY.

On the basis of the BANEBERRY experience and investigation, the Commission has taken action to strengthen technical and administrative procedures to substantially reduce the probability of a similar future occurrence. These actions include but are not limited to: more extensive geologic and geophysical investigations; the institution of more conservative area controls and restriction of forward area personnel and facilities to minimum requirements; and a more vigorous analytical program so as to better understand the behavior of nuclear detonations in the various environments which may be encountered in emplacing underground tests, with special emphasis on more conservative burial depth for low yield experiments.

1. DESCRIPTION AND LOCATION OF THE EXPERIMENT

BANPBERRY was an underground nuclear test of less than 20 kilotons designed by the Lawrence Radiation Laboratory-Livermore, California, in support of requirements established by the Department of Defense. The test was conducted in Area 8, drill hole U8d, of the Nevada Test Site. The nuclear device was emplaced in an 86-inch-diameter hole at a depth of 910 feet. The emplacement geometry of this test was that of an evacuated line-of-sight (LOS) pipe equipped with fast closure systems and running vertically from near the explosive device to the surface. The hole outside the LOS pipe was backfilled to the surface with sand, gravel, and plastic stemming materials.

2. CONTAINMENT ANALYSIS

2.1 Shot-Time Phenomena

All programmed operations were performed in a normal and anticipated manner until the release of radioactivity commenced. Signals from instruments near the explosion indicated that containment features functioned as planned.

At 3.5 minutes after detonation, a release of radioactivity began from a location estimated to be 300 feet S60° W of surface zero. The initial point of release rapidly elongated until radioactivity was issuing from a fissure oriented radially to surface zero and bearing S60° W. The release occurred over a distance of 315 feet, extending from 375 feet to a distance of 60 feet from surface zero. After surface collapse, 16.5 minutes after detonation, release continued with diminished velocity from that portion of the fissure outside the collapse crater. Fairly rapid venting of steam continued until about H plus 2 hours, after which only a lazy cloud of vapor could be seen drifting up from the portion of the fissure outside the crater. This continued for nearly 24 hours.

Previous ventings through emplacement holes or fissures were reduced to seepage or were stopped entirely upon surface collapse. The BANEBERRY test is in marked contrast to this behavior, supplying the evidence that a large portion of the release path was external to the chimney* region and therefore not disrupted by chimney growth and surface collapse.

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* Chimney: The chimney is that structure formed by collapse of the underground cavity created by an underground nuclear detonation. As the overlying rock falls into the cavity, a rubble-filled region progresses upward forming a generally cylindrical outline. The ultimate chimney height depends on yield and rock properties and frequently, as it did in BANEBERRY, reaches the surface and causes a subsidence crater.

The final surface crater, formed by chimney growth to the surface, is 78 feet deep. The crater outline is slightly oval with an average diameter of 455 feet. The depth to diameter ratio is somewhat greater than normally experienced for a test at this yield and depth in the central portions of Yucca Flat.

2.2 Yield and Energy Coupling

2.2.1 Radiochemical Analysis

Radiochemical yield determination presently available on the BANEBERRY device indicates the yield was about as expected.

2.2.2 Seismic Measurements

Initial yield estimates for BANEBERRY were developed from ground motion amplitudes measured at distant seismic stations. Three different organizations estimated yield values independently and all of these estimates were considerably greater than the yield as determined by radiochemical analysis.

Yield determination for an experiment by seismic measurements relies on comparison with a test of known yield detonated nearby and in the same geologic environment. Only two other tests had been conducted near BANEBERRY. DISCUS THROWER, located 2,100 feet north-northeast, was detonated in tuff at a depth nearer to the subsurface Paleozoic carbonate bedrock than BANEBERRY. CYATHUS, located 2,000 feet east, was detonated in tuff at a depth more remote from the carbonate rocks. The yield determinations for BANEBERRY were established assuming that one or the other of the nearby tests represented the BANEBERRY environment. The facts indicate that much stronger ground motion coupling occurred for BANEBERRY than for these two nearby tests and can be explained by the geologic differences which are now known to exist for these tests.

Enhanced coupling factors of the required magnitude can easily be attained by the existence of a water content near saturation in the test medium. Physical properties determined for samples obtained postshot from the detonation medium (600 feet horizontally from the shot point) reveal the water content is indeed very high. The DISCUS THROWER and CYATHUS shot media were not saturated and consequently it is not proper to establish a yield based on seismic measurements for BANEBERRY by comparison with these two events. Had seismic amplitude curves established for saturated media been applied to BANEBERRY, a seismic yield consistent with the radiochemical yield would have resulted.

2.3 Hole History

Drill hole U8d, the uncased BANEBERRY emplacement hole, was drilled 126 feet northwest of the U8a10 satellite hole.* Drilling commenced October 25, 1970, and was completed December 8, 1970. The 86-inch hole was drilled to a depth of 980 feet. A caliper log showed filling to 891 feet with significantly enlarged zones below 700 feet. Cleanout operations resulted in continued filling and sloughing of the hole below 700 feet. Eight successive cementing and redrilling sequences were necessary to complete the hole to a final depth of 942 feet. Completion of the hole required 38,000 cubic feet of cement with an estimated 8,300 cubic feet of cement remaining in the 700- to 928-foot interval after all redrilling operations had been completed.

The cement used in the hole was a basic oil-well-type cement with nylon fibers added to reduce its brittleness. This cement is commonly used in NTS holes. The mix used contained very little carbonate (less than 4 percent) and consisted of 44 percent water by weight.

The problems in completing the hole are attributed to the high montmorillonite clay content of the tuff below 700 feet. Montmorillonite may swell 50 percent in volume when exposed to water and tends to slough when wet so that as the hole is drilled sloughing of the walls will occur. The drilling technique used on this hole required a 200- to 400-foot head of water in the hole at all times, therefore more than enough water was available to account for flowing of the clay. Similar problems were encountered with some of the DISCUS THROWER satellite holes, especially U8a9, U8a10, and U8a11 which bracket the BANEBERRY site. A downhole television survey two days after hole U8d completion indicated no water inflow had occurred during this period, and the foot of water left in the hole after completion was still present. Considering the natural state water content of the shot medium, it is unlikely that significant amounts of water could have been added to the formation during drilling operations.

The amount of difficulty encountered in drilling this hole is not unique in the NTS experience. Several holes have required extensive cementing to permit hole completion and some of these were used in an uncased condition. Neither is the diameter unusual for an uncased hole and, indeed, several this size and larger have been successfully utilized.

The cause of the hole completion problems on U8d appears almost unique because such high montmorillonite clay content is now known to exist only at U8d and some of the U8a satellite holes.

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* U8a10 satellite hole was drilled prior to the detonation of the DISCUS THROWER test to determine subsurface geology at the test area.

2.4 Stemming Emplacement

Several modifications of the original stemming design were made. These modifications involved differences in the final location of the various stemming materials. The stemming of the emplacement hole did fill the hole around and above the device canister, and there is no evidence that the stemming deviations contributed in any substantial manner to the venting.

2.5 Geology of the BANEBERRY Site

Preshot knowledge of subsurface geology in the BANEBERRY area was based on information obtained from the DISCUS THROWER satellite holes, the closest of these, U8a10, being 126 feet southeast of the BANEBERRY site.

The site was intentionally selected to provide high seismic velocities in the first 200 feet above the detonation point. Calculations show that this is advantageous in assuring closure of the LOS pipe. The average velocity from 910 feet to the surface, based on signals from BANEBERRY itself, was 6,400 feet per second. Even higher velocities were indicated preshot by sonic logs in the U8a10 hole. Density of the material above the shot point is also high, averaging about 2.15 g/cm^3 as calculated from density logs in U8a10. Only one estimate of porosity and water content was available preshot from near the shot point environment. A core from U8a10, taken between 977 and 985 feet in the same geologic unit as the BANEBERRY working point, had a porosity of 40.6 percent, and 98 percent of the pore space was filled with water. During drilling, this core was in contact with drilling fluid, however, and it was not believed possible to establish the true in situ water content from this information. Carbonate content estimated for this same core was about 15 percent. Postshot analysis of cuttings from the BANEBERRY emplacement hole shows lower values ($\sim$5 percent) for CO_2 content.

As mentioned earlier, a feature peculiar to the BANEBERRY site and some of the DISCUS THROWER satellite holes is the presence of very large amounts of montmorillonite clay. This clay, when present in large quantities, will form a relatively impermeable barrier to water flow. Downward-moving water would be held back by these clay zones permitting the saturated or nearly saturated regions to exist in the BANEBERRY shot zone. Also the fact that BANEBERRY is located on the axis of a subsurface trough would serve to concentrate and localize water around the BANEBERRY site. In addition, there is a change in character of the Paleozoic bedrock just to the east of the BANEBERRY site from carbonate rock on the east to quartzite and argillite on the west. The quartzite and argillite being less permeable would drain away water at depth less rapidly, thus contributing to the existence of regions of high water content. Post-BANEBERRY drilling at a location (Ue8f) 600 feet southeast of U8d obtained samples from the shot horizon which show the tuff to be nearly saturated and to contain very large amounts of water.

In addition to these unusual features, it should also be pointed out that the alluvium in the upper 700 feet is a relatively well-cemented material with densities and sonic velocities much higher than normally associated with alluvium found nearer the center of Yucca Flat. It is not representative of those areas of the NTS where most of testing experience has been gained and where extensive containment guidelines have been developed.

BANEBERRY caused surface faulting and cracking to occur. Similar faulting occurred on DISCUS THROWER but the magnitude of the BANEBERRY faulting is unusual for a shot of this low yield. These faults indicate that considerable in situ tectonic stress exists in this area. The motion and attitude of the faults are consistent with the regional stress pattern known to exist in Pahute and Rainier Mesas. These faults are indicative of a minimum principal stress axis oriented northwest-southeast. The alignment of faults and the venting fissure along the direction of maximum principal stress and the normal fault type of displacement on the faults implies a low stress in the northwest-southeast direction.

The nature of the BANEBERRY faults and fissures implies that a preshot weakness did exist and controlled shot-time response of these features. The fissure through which the venting occurred may be traced to the northeast beyond its release path but shows no fault-type movement--only separation perpendicular to the fissure. Its radial nature indicates it may have been generated by the ground shock and doming of the ground above the cavity with its azimuth being determined by the minimum principal stress orientation.

2.6 BANEBERRY LOS Containment Diagnostics

To prevent release of radioactive material through the LOS pipe, various closure mechanisms were employed. Performance of the closure mechanisms was monitored by instrument stations placed at various locations in the LOS pipe. The sensors located at these points measure temperature, pressure, velocity, acceleration, and radiation.

Analysis of the data received from these sensors shows that the behavior of the LOS pipe at, and subsequent to, shot time was within the range of experience on contained vertical LOS tests and in some respects was better. Pressure in the LOS pipe above 250 feet, at times of seconds until after venting began, was at less pressure than is normally experienced at similar times on other LOS tests. At late time, 9 minutes after zero time or 5.5 minutes after venting commenced, this same measurement indicated higher pressures than are normally experienced for LOS pipe tests emplaced in a drier media at comparable times.

Data from the sensors indicate that the LOS pipe and stemming (above 250 feet and 350 feet, respectively, from the detonation point) were not a part of the initial vent path and did not contribute to the eventual release. Since the diagnostic data for the lower portion of the LOS pipe are consistent with previous experience for contained tests, the pipe in that range is not viewed as a primary cause of the release.

2.7 Conclusions

The primary cause of venting of the BANEBERRY test was an unexpected and unrecognized abnormally high water content in the medium surrounding the detonation point. (This high water content is believed to be in no way associated with the drilling operations.) This increased the coupling of energy into the earth and also extended the duration of high pressures in the cavity. The end result was the experiment's behaving as if it were of higher effective yield and therefore emplaced at too shallow a depth. Had the same test occurred in the more usual test environment, without the high water content, it is believed that it would have been satisfactorily contained underground.

The geology at the BANEBERRY site is significantly different than that which is known or inferred to represent the bulk of underground test experience at the NTS. Depth of burial necessary for containment developed empirically from this test experience is medium dependent and should not be routinely applied to tests in new geologic situations.

Present containment criteria for vertically emplaced tests are adequate for those areas of the NTS where the geologic environment is the same as that where the bulk of testing experience has been acquired. These criteria are conservative for high yield tests, many of which are below the water table, but less so for low yield detonations. For low yields, an unusual environment may result in phenomena sufficiently different from experience to lead to release of radioactivity. Both detailed geologic information and a more conservative burial criteria would help avoid unexpected developments when testing in new areas. For high yield tests, the large absolute depths involved prevent propagation of fissures to the surface, so that there is less sensitivity to geologic variations.

3. RADIOLOGICAL SAFETY ACTIVITIES

3.1 Control Point Operations

For each underground nuclear test, briefings are held in the hours preceding the test to discuss meteorological conditions and to assess the predicted conditions at shot time and during the immediate postshot hours. The first BANEBERRY readiness briefing was held at 2:30 p.m., PST, on December 17, 1970 (D minus 1). It was noted that all actions were on schedule to assure technical readiness for a zero time of 7:30 a.m., PST, on December 18, 1970.

At the D-day morning readiness briefing, weather predictions for shot time and fallout predictions based upon predicted winds and an assumption of an inadvertent and extensive release of radioactivity were presented to the Test Manager and his Advisory Panel. It is a safety evaluation procedure for every experiment to assume such a hypothetical incident in order to determine that an underground test can be conducted safely. Based upon the foregoing information, the Test Manager and his Advisory Panel concluded that the onsite exclusion area and the offsite monitors and control procedures were adequate for safe conduct of the test.

The detonation proceeded on schedule. Subsequent to the release of radioactivity, action was taken to expand the Test Site exclusion areas. All northbound traffic into forward areas from Mercury was halted. Evacuation of personnel from the exclusion areas was completed at approximately 9:15 a.m., PST.

3.2 Onsite Radiological Safety Activities

3.2.1 Personnel Radiological Surveys

During the evacuation of personnel, preparations were made at Control Point 2 and the decontamination pad to survey these personnel, their personal effects, and vehicles. A personnel decontamination station was set up inside building CP-2. All contaminated clothing and personal effects were monitored, inventoried, and bagged. Individuals whose clothing exceeded 0.3 mR/hr were provided with white paper or cloth overalls and rubber boots and their personal effects were collected.

Approximately 900 personnel were surveyed. Of these, 86 personnel were decontaminated at CP-2 and 66 of these were sent to Mercury for thyroid activity measurements. Of those counted at Mercury, 18 were sent to the Southwestern Radiological Health Laboratory (SWRHL) whole-body counter in Las Vegas for additional measurements. Dose data for those personnel having measured thyroid activity are given in Figure 1.

3.2.2 Onsite Doses to Persons

The highest radiation doses to persons onsite occurred on the day of the test and resulted from cloud passage over Area 12. Based on initial film badge readings and thyroid monitoring, no exposure of onsite personnel was in excess of the occupational standards in AEC or Federal Radiation Council occupational guides for normal peacetime operations. The highest exposures (see Table 1) were received by two security guards and were about 30 percent of the Federal Radiation Council's quarterly guide for whole body and about 37 percent of the guide for thyroid exposure. The exposure to the lens of the eye was almost equal to the exposure limit.

3.2.3 Equipment Decontamination

More than 500 privately owned vehicles were surveyed following the Area 12 evacuation and more than 400 were found to be contaminated. All the vehicles

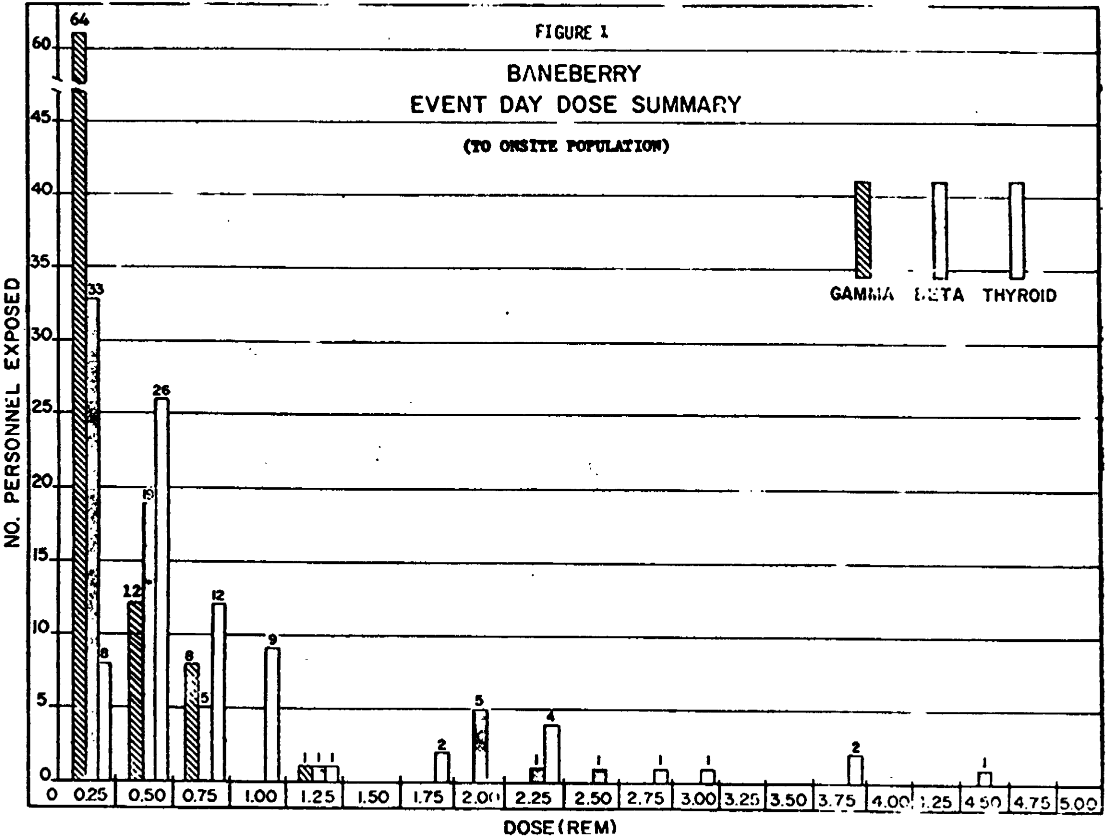

FIGURE 1

BANEBERRY
EVENT DAY DOSE SUMMARY

(TO ONSITE POPULATION)

TABLE 1

BANEBERRY - MAXIMUM OCCUPATIONAL EXPOSURES

CRITICAL ORGAN	HIGHEST DOSE	FEDERAL RADIATION COUNCIL RADIATION PROTECTION GUIDE (rems/quarter)
Whole Body	1.0 rems	3
Lens of Eye	2.4 rems	3
Skin	4.6 rems	10
Thyroid	3.7 rems	10

TABLE 2

BANEBERRY - MAXIMUM EXPOSURES TO THE GENERAL PUBLIC (INDIVIDUALS)

CRITICAL ORGAN	HIGHEST DOSE	FEDERAL RADIATION COUNCIL RADIATION PROTECTION GUIDE* (rems/year)
Whole Body	0.036 rem	0.5
Thyroid (child)	0.13 rem	1.5
Thyroid (adult)	0.5 rem	1.5

*For individuals in the general population for normal peacetime operations.

except 86 were decontaminated utilizing water spray and vacuum cleaners and returned to their owners.

The 86 remaining vehicles had higher levels of contamination and were kept until they could be more thoroughly decontaminated. The procedure was delayed because of freezing weather, so many of the owners were provided with rental automobiles. All the vehicles have been returned to their owners.

3.2.4 Areal Radiation Surveys and Decontamination

Radiation surveys were subsequently conducted in Area 12 Camp on December 20, December 21, and December 22, 1970, using portable survey instruments. Exposure rates at three feet above the snow- and ice-covered ground varied from 5 to 9 mR/hr on the 20th; 2 to 3 mR/hr on the 21st; and 1.5 to 2.5 mR/hr on the 22nd.

Decontamination of Area 12 Camp commenced on January 22, 1971. The initial phase began with decontamination of the roads in Area 12 using high pressure fire trucks and water trucks. The second phase began with decontamination of the interiors of housing trailers. The Camp cleanup was completed for reopening on February 1, 1971.

3.3 Offsite Radiological Safety Activities

The surveillance and dosimetry networks, as well as the techniques used in special surveillance and monitoring for the BANEBERRY test, are discussed in the report NVO-40 (Second Edition). All of the routine stations in the Air Sampling Network west of the Mississippi River were operational and the Standby Milk Network was activated in California, Idaho, Wyoming, Colorado, and Utah. Additional environmental sampling was performed in Nevada, Utah, California, Minnesota, South Dakota, North Dakota, Arizona, Colorado, Idaho, Montana and Wyoming.

All exposures and doses in the offsite area were well within the FRC and AEC guidelines for normal peacetime situations. The maximum exposures to the general public are summarized in Table 2 and discussed in the following paragraphs.

3.3.1 External Exposure

Twenty-six monitors were in the field on December 18 (D-day) to obtain measurements of exposure rates during cloud passage. The maximum exposure rate recorded at a populated location was 0.5 mR/hr at Blue Jay Maintenance Station (2 adults, 3 children). The maximum measured offsite exposure rate was 1.2 mR/hr at an unpopulated area near Queen City Summit, Nevada. Remonitoring on December 19 showed a maximum residual 0.3 mR/hr 17 miles east of Tonopah on Highway 6. The maximum residual exposure rate at a populated location was 0.1 mR/hr at Diablo Maintenance Station (3 people), Blue Jay Maintenance Station (5 people), and Clark Station (1 person). The total offsite population residing at Tonopah and other small communities, as well as at ranches and highway maintenance stations which were within the area of positive D-day ground monitoring, was about 4,000 to 5,000 persons.

External gamma exposures to infinity in the offsite area were estimated from data using hand-held survey meters, recording rate-meters, and thermoluminescent dosimeters. The line of maximum deposition appears to have passed almost due north of the test point, crossing Highway 6 between Warm Springs and Tonopah. The highest estimated infinity external exposure* at a populated location was 0.036 rem which occurred at Clark Station as a result of cloud passage and subsequent ground deposition. There was only one resident in the immediate vicinity where this level was observed. This level of external, whole-body gamma radiation is about one-fifth of the Federal Radiation Council Radiation Protection Guide for the general population or about one-fifteenth of the Radiation Protection Guide for an individual in the population. The Radiation Protection Guide is defined as the radiation dose which should not be exceeded without careful consideration of the reasons for doing so; every effort should be made to maintain radiation doses as far below this guide as practicable. A few persons (less than 10) entering the general vicinity on the following day received exposures of about 0.02 rem from deposition.

3.3.2 Ingestion Doses

The Federal Radiation Council has provided Radiation Protection Guides for evaluating situations where there are potential exposures to iodine-131. The Radiation Protection Guides applicable to the general public assume radioiodine intake by children and three ranges of daily intake are defined:

Range I:	0 to 10 micromicrocuries (picocuries) per day
Range II:	10 to 100 picocuries per day
Range III:	100 to 1,000 picocuries per day

Continuous daily intake of about 100 picocuries of iodine-131 (the top of Range II) per day for one year would lead to exposures not exceeding the Radiation Protection Guide value of 0.5 rem per year for a suitable sample of the population.

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*"Infinity external exposure" is the cumulative exposure which one might experience from radioactive material deposited in the area if he were to remain in that location for the rest of his life. Depending on the nature of the radioactive material, the majority of the exposure could be delivered over a time period varying from minutes to years.

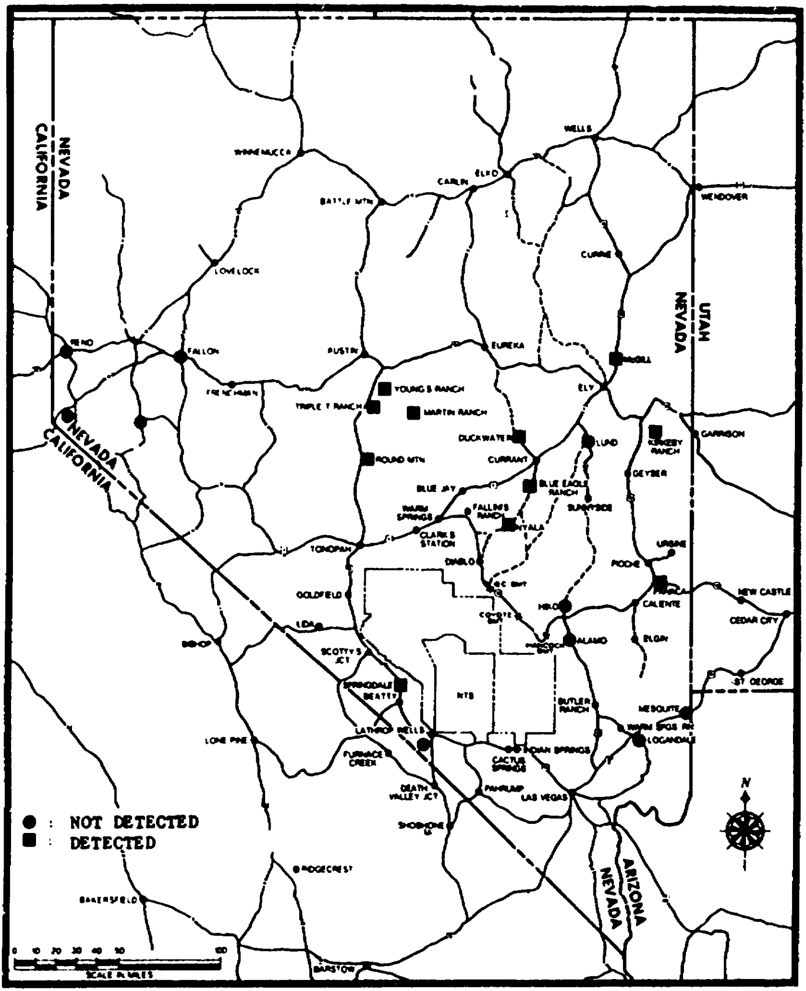
The Federal Radiation Council Protective Action Guide is the projected dose to individuals in the general population which warrants protective action following a single contaminating event. The Protective Action Guide will not be exceeded if the average projected dose to the thyroids of a suitable sample of the population does not exceed 10 rems.

Ingestion of radioiodine can occur through use of contaminated food or water. One important route is the milk-thyroid pathway, another is the drinking water-thyroid pathway. Projected ingestion doses from the only other radionuclides (tritium and cesium-137) found in milk are orders of magnitude lower than thyroid doses from radioiodine. Figure 2 shows those locations in Nevada where radioiodine was detected in milk samples.

The highest radioiodine levels in milk occurred at a ranch near Springdale, a few miles north of Beatty, Nevada. The milk supply at the ranch with the highest concentration was sampled daily since this milk was being used by other families in the Beatty area. The highest level of iodine-131 observed was 810 picocuries per liter (pCi/l) of milk on December 26 and December 27, 1970. These two samples were in Range III of the Federal Radiation Council's guide for daily intake of iodine-131. Since the milk concentrations resulted from a single short-term contaminating event which ceased on actual milk sampling and assuming continued use of milk by the children, would be about 14,000 picocuries. This represents approximately 40 percent of the annual Radiation Protection Guide and is well within Range II. Although the highest milk concentration represented a very small fraction of the Federal Radiation Council Protective Action Guide value, from December 31, 1970, through January 10, 1971, distribution of the milk was terminated as a precautionary measure. The children (ages 13 years and 15 years) at the ranch near Springdale continued to drink the milk. The highest estimated thyroid exposure from inhalation and milk ingestion was 130 mrem (0.13 rem) to a two-year-old child in the Beatty, Nevada, area.

Radioiodine was also detected in milk samples from five locations outside Nevada: Bakersfield, California; Jerome, Idaho; Powell and Laramie, Wyoming; and Mt. Pleasant, Utah. The highest levels found at these five locations were at Bakersfield, California, and Mt. Pleasant, Utah, where the peak iodine-131 concentration was 60 pCi/l, corresponding to a projected infant thyroid dose of less than 10 mrem. As indicated above, 60 pCi/l of milk is within Range II of the Federal Radiation Council's guide for a single day's intake of iodine-131.

After the environmental sampling program following the BANEBERRY venting was ended, it was learned that sheepherders in the area north of the NTS where radioactivity had been measured, were using melted snow as a source of drinking water and cooking water. During the weeks following BANEBERRY, the sheepherders were in an area from about 30 miles east of Eureka, Nevada on Highway 50, south to Duckwater, Nevada, Based on sampling results in the general area, on information obtained from the eight sheepherders about their location and water consumption, and on snowfall records, it was estimated that the dose to their thyroids from radioactive iodine



RADIOIODINE IN MILK - NEVADA
BANEBERRY

FIGURE 2

was about 0.5 rad, plus or minus a factor of three. The large uncertainty in the estimate results from the fact that there is no detailed information on radioactive contamination levels at the exact locations where the sheepherders were; the old snowpack was diluted by new and uncontaminated snow; and there is no information about distribution of the radioactivity at any depth in the snowpack.

3.3.3 Inhalation Doses

Fresh fission products, including radioiodine, were detected in air samples collected in the Air Surveillance Network. The highest estimated inhalation dose in the offsite area was 90 mrem to a hypothetical infant thyroid, based on the level of radioiodine detected in the air filter sample collected at Stone Cabin Ranch, Nevada (which was unpopulated during cloud passage). As noted previously, the Federal Radiation Council Radiation Protection Guide for thyroid is 1,500 mrem per year. The highest estimated inhalation dose outside Nevada was 5 mrem at Garrison, Utah, and Idaho Falls, Idaho. The estimated dose at Salt Lake City, Utah, was 4 mrem.

3.3.4 Cooperative LRL-University of Utah Radioecological Studies

Dr. R. C. Pendleton of the University of Utah and the Biomedical Division of the Lawrence Radiation Laboratory are cooperatively conducting radioecological studies of the decay of fallout radionuclides in Utah. Unrelated to BANEBERRY, the joint effort had just completed a 7-week period of air sampling from 16 stations throughout the State of Utah just before the BANEBERRY test. Dr. Pendleton was apprised of the BANEBERRY test in time to activate the statewide air sampling network before radioactivity reached Utah.

Inhalation doses estimated from preliminary radionuclide concentrations measured by Dr. Pendleton's group at stations with complete data agree very well with doses estimated from concentrations observed by the Air Surveillance Network discussed above. Estimated inhalation doses to an infant receptor at 3 of Dr. Pendleton's stations within 20 miles of Salt Lake City were 8 mrem, 5 mrem, and 2 mrem, compared to the Air Surveillance Network Salt Lake City dose estimate of 4 mrem. The inhalation dose at Cedar City, Utah, estimated from Dr. Pendleton's data, was 0.08 mrem, compared to 0.07 mrem estimated from the Air Surveillance Network Cedar City station results.

3.4 Conclusions

Action was taken by the AEC at one farm close to the Test Site to discontinue public distribution of milk for a few days. This action was not required by the Federal Radiation Council Protective Action Guide but was in keeping with the AEC's policy to reduce exposures to the lowest extent practicable. Potential thyroid exposures to the few individuals in the nearby offsite areas were reduced by this action.

In assessing the overall radiological consequences of this accidental release, the data indicate the radiation exposures to workers on the Test Site and to individuals within the general population outside the Test Site did not exceed the radiation protection guidelines recommended by the Federal Radiation Council for the protection of workers and the public for normal peacetime operations.

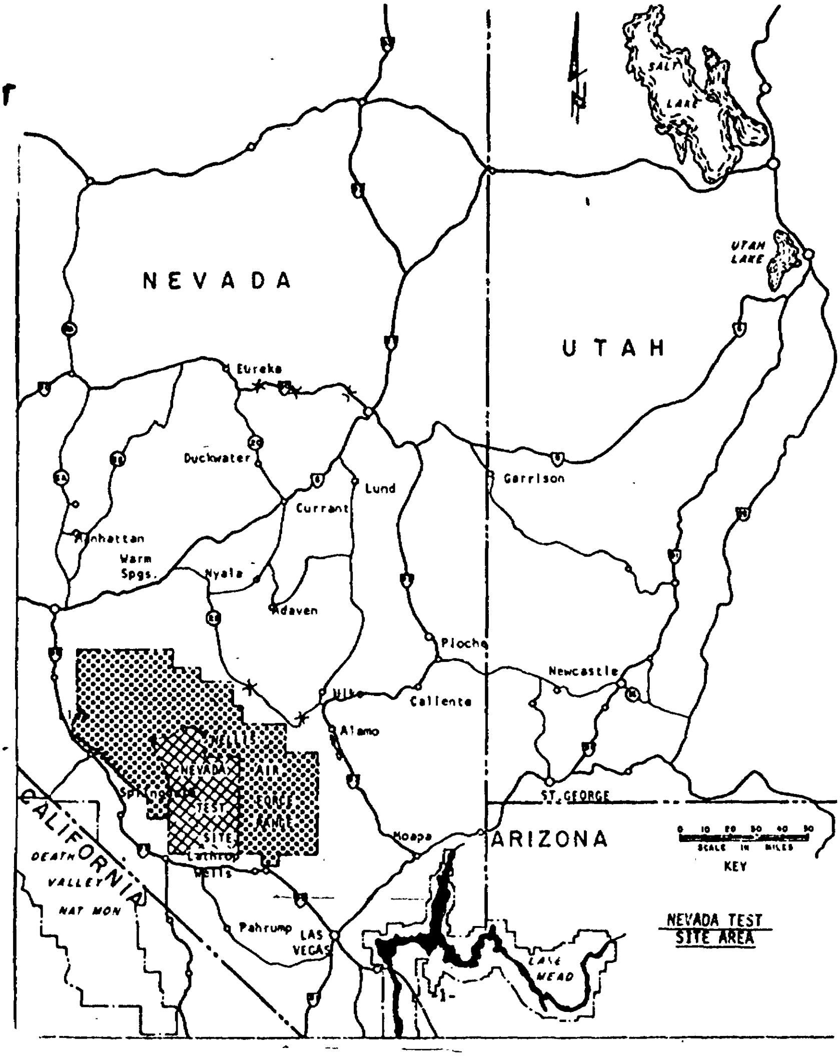
APPENDIX A

WASH-1183
UC-41

SUMMARY INFORMATION
ON
ACCIDENTAL RELEASES
OF
RADIOACTIVE EFFLUENT TO THE ATMOSPHERE
FROM
UNDERGROUND NUCLEAR DETONATIONS
DESIGNED FOR CONTAINMENT
AUGUST 5, 1963 -- JUNE 30, 1971

JUNE 1971

ROBERT E. ALLEN
DIVISION OF OPERATIONAL SAFETY
USAEC - WASHINGTON, D. C.


NEVADA
UTAH
SALT LAKE
UTAH LAKE
Eureka
Duckwater
Lund
Currant
Manhattan
Warm Spgs.
Nyala
Adaven
Garrison
Pioche
Newcastle
Hiko
Caliente
Alamo
ST. GEORGE
NELLIS AIR FORCE RANGE
NEVADA TEST SITE
Springdale
Lathrop Wells
Moapa
ARIZONA
CALIFORNIA
DEATH VALLEY NAT MON
Pahrump
LAS VEGAS
LAKE MEAD
0 10 20 30 40 50
SCALE IN MILES
KEY
NEVADA TEST SITE AREA

INTRODUCTION

During the period August 5, 1963, through June 30, 1971, the Atomic Energy Commission has announced the detonation of 220 nuclear tests at the Nevada Test Site, which were designed to be completely contained underground. Of these 220 underground tests, 17 tests inadvertently released sufficient radioactivity to the atmosphere to be detected by ground monitors or ground monitoring equipment off the testing site. Post-shot tunnel ventilation the day after one other test also resulted in a positive offsite reading.

Radiological monitoring and surveillance in the offsite areas around the Nevada Test Site (NTS), are conducted for the AEC by the Environmental Protection Agency's Western Environmental Research Laboratory (WERL), through a Memorandum of Understanding between the two agencies. This monitoring was formerly conducted by the U. S. Public Health Service, Southwestern Radiological Health Laboratory (SWRHL).

The following information is provided concerning the offsite radiological situation for each of the 17 tests.

1. The name and date of the test.
2. The depth of burial of the device.
3. The quantity of radioactivity released to the atmosphere.
4. The types of radionuclides identified in the release.
5. The highest air concentrations detected in the offsite area.
6. The highest gamma exposure levels detected in the offsite area.
7. The highest levels of radioiodine detected in milk.
8. The thyroid dose where sufficient radioiodine was detected that could lead to a measurable thyroid dose.

Estimates of the quantities of radioactivity are based upon the calculated quantity of the initial release that remains at twelve hours after the release occurred (R+12 hrs.). In a prompt venting situation the major portion of radioactivity consists of very short half-life radionuclides. These short half-life radionuclides are of little or no health significance, since people are not present in the physical areas where these radionuclides may occur. Work areas on the NTS located in the downwind direction from a scheduled nuclear test are routinely cleared of personnel just prior to any underground test. These short half-life radionuclides will essentially all decay before reaching the off-NTS areas.

In a delayed seepage type release these short half-life radionuclides generally represent only a very small fraction of the total release, or may not be present at all. Hence, to provide a more meaningful estimate of the quantities of radioactivity released to the atmosphere, that could affect man, and to provide a point for comparison with other releases, the time selected and in common usage is the quantity of the radioactivity which was released and remains at 12-hours after the release occurred. Throughout this summary, the total quantity of radioactivity released is expressed in this R+12 hour context.

Where a definite cause for the release of radioactivity could be determined, these have been indicated. Some of these releases could not be readily ascribed to a specific cause, but may be categorized as a seepage occurring through very small cracks and fissures in the ground above the point of detonation. Such releases are usually small in total quantity and consist entirely of noble gases, i.e., xenon and krypton.

In summary, all but 2 of these 17 tests were in the low kiloton range (0-20 KT). The exceptions were the NASH and POD tests which were in the low-intermediate yield (20-200 KT) range. The actual depth of burial of these tests ranged between 390 feet and 1465 feet. The low-intermediate yield devices were buried at depths of 1000 and 1200 feet. The radioactivity released was essentially gaseous nuclides of xenon, krypton, and iodine except for the PIKE, PIN STRIPE, HUPMOBILE and BANEBERRY tests which released particulate matter as well as gaseous nuclides.

The highest radioiodine content found in milk where children were living was at the Schofield Dairy near Hiko, Nevada, where a peak level of 4.8 nanocuries of iodine-131 per liter of milk was recorded following the PIN STRIPE test. This would result in exposures less than one-tenth of the Protection Action Guide of the Federal Radiation Council. As a precautionary measure to minimize exposures, an arrangement was made by the AEC with the dairy owner to place these milk cows on dry feed for about three weeks. In addition, to develop a better understanding of the thyroid uptake at these low levels of radioiodine, 90 people residing in this area were examined. Low levels of radioiodine were detected in the thyroid of 19 of the 90 people studied. The projected doses to the thyroid of these 19 people ranged from 50 to 300 millirads (equivalent to millirems). The Federal Radiation Council's guide for exposures of the thyroid is 1,500 millirems per year to an individual in the general population.

The highest potential external whole-body gamma radiation exposure resulted at Cactus Springs, Nevada, following the PIKE test. The total exposure to an individual at this location was calculated at about 55 millirems. This amount of radiation exposure can be compared with the 100 to 150 milliroentgens average dose humans receive from natural radiation every year. The Federal Radiation Council's guidance for whole-body exposure to an individual in a population is 500 millirems per year.

Based upon all the monitoring data collected following these releases, it is concluded that exposures to the public from these tests did not exceed the Radiation Protection Guides for the general population recommended by the Federal Radiation Council and approved by the President for the guidance of Federal agencies.

TESTS DETECTED OFF THE NTS

EAGLE	December 12, 1963
PIKE	March 13, 1964
PARROT	December 16, 1964
ALPACA	February 12, 1965
TEE	May 7, 1965
DILUTED WATERS	June 16, 1965
RED HOT	March 5, 1966
PIN STRIPE	April 25, 1966
DOUBLE PLAY	June 15, 1966
DERRINGER	September 12, 1966
NASH	January 19, 1967
UMBER	June 29, 1967
DOOR MIST	August 31, 1967
HUPMOBILE	January 18, 1968
POD	October 29, 1969
SNUBBER	April 21, 1970
BANEBERRY	December 18, 1970
MINT LEAF	May 5, 1970 (controlled release of radioactivity occurred during post-shot tunnel ventilation on May 6, 1970.)

EAGLE TEST

This nuclear detonation occurred at the Nevada Test Site, on December 12, 1963, at 0802 PST, in a vertical hole 541 feet deep in alluvium. The yield of this device was less than 20 Kt.

Immediately following the detonation, a small pulse of gases was observed to emanate from the Line-Of-Sight (LOS) pipe at surface zero. Aircraft sampling of this puff-like cloud did not reveal any radioactivity, only smoke particles. About thirty seconds later, steam-like radioactive effluent began emanating from the LOS pipe and continued until the surface collapsed at 3.3 minutes after the detonation, at which time the release of radioactivity stopped. This event contained an experiment involving a LOS pipe to the surface which did not properly sealoff as it was designed to do. The estimated total radioactivity released to the atmosphere calculated at R+12 hours after the release was 760 curies. The major fractions of the activity identified in this gaseous effluent were: iodine-133, iodine-135, iodine-132, xenon-135, and tellurium-132.

Following the releases, the cloud rose to about 250 feet above the surface. Surface and near surface winds carried the gaseous effluent to the southwest. Aerial tracking of the cloud was conducted until the sensitive detection instruments in the tracking aircraft could no longer detect any airborne radiation levels above background. Over central southern California, about 140 miles from the point of release, the effluent cloud became so diffused and dispersed that identification of airborne radioactivity could not be made.

Nine mobile radiation monitoring teams were deployed offsite in the southern sector from the NTS. No gamma radiation levels above background were detected in the downwind offsite sector. Small amounts of radioactivity were detected on air filters collected in the offsite area. The highest concentration of gross beta activity occurred at Death Valley Junction, California, between 0930 and 1550 hours on December 12, at 24 picocuries/cubic meter (pCi/m^3). This filter and the charcoal cartridge contained concentrations of iodine-133 at 20 and 15 pCi/m^3 respectively. The radioactivity collected by all other air filters and charcoal cartridges was essentially background. Seventeen milk samples were collected from areas under the cloud trajectory and no fresh fission products were detected in any of these milk samples.

PIKE TEST

This nuclear detonation occurred at the Nevada Test Site, on March 13, 1964, at 0800 hours PST, in a vertical hole, 390 feet deep. The yield of this device was less than 20 Kt.

The cause of this release has been attributed to the geologic weakness of the media, and possibly preshot drilling induced weakness in the media surrounding the casing. Small cracks and fissures near surface zero were opened during this release. It is estimated that about 130,000 curies of activity calculated at R+12 hours were released to the atmosphere.

Beginning almost immediately after shot time, radioactivity issued from the surface zero area. This radioactivity continued to come out of the surface zero area until the subsidence was formed at one minute and nine seconds after the detonation. At that time, the release of radioactivity stopped. The radioactive effluent cloud top was measured at 2640 feet above the terrain. The radioactivity was tracked by aircraft southeastward, past Las Vegas, Nevada. A second aircraft, equipped with very sensitive detection instruments, tracked the airborne radioactivity to a distance of about 60 miles south of Las Vegas. At this point, the sensitive detection instruments in the tracking aircraft could no longer detect airborne radioactivity. Some spotty patches of airborne radioactivity just above background were detected in southern Arizona and California on the following days.

The highest potential external gamma radiation exposure at a populated area was at Cactus Springs, Nevada. Considering all possible sources of exposure to people, it is estimated that the maximum whole-body gamma radiation exposure that could have resulted would have been less than 55 mR infinite dose. An estimate of possible thyroid dose to children at Cactus Springs, is one millirad. This is based upon inhalation calculations since no milk was produced at this location.

Although low levels of radioiodine appeared in some samples of unprocessed milk from individual farms, none was found in commercially available milk. At that time of year, all of the cows in the Las Vegas area were on dry feed. Unprocessed milk samples collected at farms in southern Arizona and California following this test were found to contain iodine-131, at peak levels of 50-80 picocuries per liter (pCi/l).

The highest concentrations of gross beta air activity and of iodine nuclides found on air filters are listed in the accompanying table.

HIGHEST CONCENTRATIONS MEASURED ON AIR FILTERS

Station	Collection Period	Gross Beta (pCi/m^3)	Charcoal Cartridges I-131	I-133 (pCi/m^3)	I-135
Cactus Springs	0840/13th to 1120/13th	50,000	ND*	700**	510
Cactus Springs	1128/13th to 1503/13th	9,000	ND	98	96
Cactus Springs	1505/13 to 1141/14th	23	Trace	4.5	Trace
Indian Springs	0852/13th to 1102/13th	35,000	ND	190	160
Indian Springs	1106/13th to 1530/13th	15,000	ND	123	92
Indian Springs	1503/13th to 1154/14th	42	ND	2.9	ND
Las Vegas	1140/13th to 1445/13th	14,000	ND	60	100
Las Vegas	1450/13th to 1845/13th	680	ND	10	ND
Las Vegas	1850/13th to 2348/13th	59	ND	0.8	ND

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* ND - Not Detectable

** - An analysis of the glass fiber filter indicated an additional 1000 pCi/m^3 of I-131 and 35,000 pCi/m^3 of I-133.

PARROT TEST

This nuclear detonation occurred at the Nevada Test Site, on December 16, 1964, at 1200 PST, in a vertical hole 600 feet deep. The yield of this device was less than 20 Kt.

This experiment involved a Line-Of-Sight (LOS) pipe to the surface. Collapse of the surface zero (sz) area occurred at about 4 minutes after the detonation. There was no prompt release through the LOS pipe. However, about eleven minutes after the detonation, radiation monitoring units located 300 feet north of surface zero began recording increased levels of radiation. The mechanism of this release was later found to be a crack in the LOS pipe below the surface.

Winds near the surface at shot time were to the north at about seven miles per hour. The radioactive effluent cloud did not rise to any great heights above the surface. Since winds near the surface were of low velocity and quite variable in time (this seepage continued to occur over a period of about seven days), the direction of the effluent cloud initially was to the northeast when the release began, however, during the night these surface drainage winds reversed direction bringing the effluent cloud back over the NTS. Over the several days that seepage occurred the gaseous plume varied between north and south over the test site several times, hence the overall activity cloud was widely dispersed, but generally localized over and around the NTS. It is difficult to estimate the total curies released from this seepage which occurred over a period of seven days. However, the estimate made by the Los Alamos Scientific Laboratory for this total release was about 250,000 curies calculated at R+12 hours. This release consisted primarily of xenon isotopes with the bulk of the release consisting of xenon-138.

The only offsite location where ground monitors detected levels of radioactivity above background was in an unpopulated area along Highway 25, on December 16. The peak exposure rate recorded was 0.14 mR/hr. Air samples were collected in the offsite area for two days following this test. Only one charcoal filter was found to contain fresh fission products. This was on a filter sample collected at Indian Springs, Nevada, during the period 0835 on December 16, 1964, through 0645 on December 17, 1964. The charcoal filter showed an activity of 6.6 pCi/m^3 of iodine-133. Several other air filters indicated levels of gross beta activity slightly above the normal background fluctuations, however, no fresh fission products were identified. Milk and vegetation samples gave no indication of fresh fission product contamination.

ALPACA TEST

This nuclear detonation conducted at a depth of 730 feet underground at the Nevada Test Site, at 0710 hours PST, on February 12, 1965, resulted in a release of radioactivity to the atmosphere. This release occurred as a low velocity seepage through the surface zero area. The explosive yield of this detonation was less than 20 Kt. The calculated quantity of radioactivity released and remaining in the atmosphere at R+12 hours was 29,000 curies. The radioactivity was identified as primarily cesium-138 and small quantities of krypton-85 and xenon-135.

Surface winds at the time of detonation were light and variable toward the south and southwest. Because of the low level of radioactivity, and the wide dispersion of the cloud, it was difficult for tracking aircraft to establish a trajectory for the air mass carrying the radioactivity. Thus, the tracking aircraft was unable to locate any airborne radioactivity off the Nevada Test Site.

On the day of the test, several radiation intensities of 0.01 mR/hr net gamma were measured in the vicinity of the junction of the Mercury turn off and Highway 95. This area is unpopulated beyond normal vehicular traffic. Monitors at Ash Meadows, Pahrump, Lathrop Wells, Nevada and Shoshone, California observed no readings above background. Remonitoring in the Baker-Barstow, California area on the two days following this test produced no measurements above background. Charcoal cartridges from thirteen air sampling locations collected and analyzed on the two days following the test showed no fresh fission products. Cartridges sent in from stations outside the projected cloud path were also free of fresh fission products. The maximum gross beta activity detected on an air filter was 19 pCi/m^3 at Barstow, California; this sample was collected from 1345 hours, February 12, to 0850 hours, February 13.

Charts from the 21 gamma dose rate recorders operating in the offsite area during this time showed no evidence of activity above normal background levels. No fresh fission products were detected in the three milk samples collected following this test. The samples were collected at Lathrop Wells, Nevada and Barstow, California on February 13.

Thirty-six vegetation samples were collected from thirty-three offsite locations. No fresh fission products were detected on these samples.

TEE TEST

This nuclear detonation was conducted at the Nevada Test Site, at a depth of 640 feet, at 0847 hours PDT, on May 7, 1965. The explosive yield of this detonation was less than 20 Kt.

A small release of radioactivity occurred through seepage around the surface zero area. The airborne radioactivity was tracked to the south by aircraft to a distance of about 35 miles from the test location (about 10 miles outside the test site), where the cloud became so dispersed and diffused in the atmosphere that further detection was not possible. Analysis of the effluent in the cloud indicated the nuclides released were primarily krypton, xenon, and cesium-138, with a small quantity of iodine nuclides. Based upon calculations of the quantity of activity at R+12 hours, it is estimated that 1,500 curies were released.

Gamma dose rates above background were detected by ground monitors along Highway 95 from 4 miles west of the junction of Highway 95 and the Mercury turn off, to 11 miles east of the junction. The maximum reading of 0.05 mR/hr net gamma was observed 4 miles east of the Mercury turn off on Highway 95 at 1108 hours. Charcoal cartridges from 8 air samplers were analyzed for specific gamma emitting isotopes as were the prefilters from the two Las Vegas stations. No fresh fission products were detected on these samples. The maximum gross beta activity on a prefilter was 28 pCi/m^3 taken from the sampler located 4 miles east of the Mercury turn off on Highway 95. (unpopulated). No special milk or water samples were collected following this event.

DILUTED WATERS TEST

This nuclear detonation was conducted at the Nevada Test Site at a depth of 640 feet, at 0930 hours PDT, on June 16, 1965. The explosive yield of this detonation was less than 20 Kt.

Immediately following the detonation, radioactivity was released to the atmosphere through a Line-Of-Sight (LOS) pipe experiment. The closure system on the LOS pipe did not adequately seal, permitting gaseous radioactivity to be released. The surface subsidence occurred at four minutes after the release began and sealed off the release. It is estimated that 5,900 curies of radioactive effluent were released based on R+12 hour calculations.

The winds at the time of the release, were toward the east but were light and variable, hence the effluent cloud remained over the Nevada Test Site for several hours. Ground monitors were stationed along Highway 25 from Hiko Junction to just southeast of Queen City Summit, Nevada. Only two gamma readings were observed in the area off the Nevada Test Site; these were both 0.02 mR/hr.

Charcoal cartridges from air samplers operating at Alamo, Hiko, and Ely, Nevada, were analyzed for specific gamma emitting isotopes. No fresh fission products were detected on these cartridges. Gross beta counting of prefilters showed no values in excess of normal fluctuations except for a slight rise in the gross beta count on the filter from Nyala, Nevada. This sample, which was collected between 0600 on June 16 to 0600 on June 17, contained 7.6pCi/m^3 gross beta. Filters collected at Nyala the day before and the day following this sample showed 1.6 and 2.7 pCi/m^3 gross beta.

Some of the milk samples collected after this test contained iodine-131. The highest concentration detected in milk was 130 pCi/l. None of the shorter lived iodines (iodine-132 or 133) were found in these samples.

Milk samples collected at Hiko, Nevada on June 8, 1965 and prior to cloud arrival on June 16, 1965, also contained detectable quantities of iodine-131. Two events occurred prior to the Diluted Waters Test and were probably responsible for the iodine-131 found in the milk sample collected for Diluted Waters. One was the atmospheric detonation of a nuclear device by a foreign nation on May 14, 1965 and the other was a test run of a nuclear rocket engine (not an explosion), at the Nuclear Rocket Development Station on May 20, 1965. The radioiodine found in milk samples collected subsequent to the Diluted Waters Test is probably the result of all three tests and it is not possible to assess the exact contribution of any one source.

RED HOT TEST

This nuclear detonation was conducted in a tunnel complex approximately 1330 feet underground, at the Nevada Test Site, at 1015 hours PST, on March 5, 1966. The yield of this detonation was less than 20 Kt.

About seven minutes after the detonation, radioactivity emanated from the tunnel portal and continued to seep to the atmosphere for several hours. The best estimate of the amount of radionuclides released as of R+12 hours is 1,000,000 curies. The data indicate that the majority of this effluent was of a gaseous nature, krypton, xenon and some iodine nuclides.

Offsite tracking of the effluent cloud, to the north and east was done by aircraft using very sensitive detection instruments. From this aircraft tracking data, an estimated cloud path was developed. At a location over eastern Iowa, the concentrations of airborne radioactivity became so low and the cloud so diffused that further identification was impossible. Although the random movement of the effluent cloud was tracked for over 2,000 miles within the U.S., there were no detectable levels of radioactivity deposited on the ground outside the immediate vicinity of the test site over which the cloud passed. After the cloud had moved away from the NTS, the airborne concentrations were so low that no detectable radiation exposures to the crew resulted from aircraft pentration of this cloud.

The analysis of milk samples collected at offsite locations gave no indication of iodine-131, or any other fresh fission products. Air sampling data collected by the U.S. Public Health Service, Radiation Surveillance Network detected no fresh fission products for March 6, 7, and 8, at any of their network stations, in the United States.

The highest concentration of iodine-131 on an air filter collected in the offsite areas was 18 pCi/m^3 at Lathrop Wells, Nevada. The highest external gamma exposure recorded in the offsite area was 0.05 mR/hr at 0205 on March 6, 1966, at Tonapah, Nevada.

Even though the total quantity of radioactivity inadvertently released to the atmosphere was larger than any of the previous tests discussed here, the nature of the gaseous release (principally xenon and krypton nuclides) did not lead to any measurable radiation exposure to the general population.

PIN STRIPE TEST

This nuclear detonation was conducted at a depth of 970 feet, at the Nevada Test Site, at 1138 hours PDT, on April 25, 1966. The explosive yield of this detonation was less than 20 Kt.

A release of radioactivity occurred through a small fissure that opened at the time of detonation. The radioactivity in this release was identified as primarily gaseous nuclides of xenon, krypton and iodine. An estimate of the amount of radioactivity released and remaining at R+12 hours is 350,000 curies.

The airborne effluent cloud moved off the Test Site to the east. Aircraft tracked this effluent cloud to the eastern part of Kansas and Nebraska where the sensitive instruments in the aircraft could no longer detect the very diffused and dispersed cloud.

While most of the radioactivity was deposited within the Nevada Test Site, some low levels were measured by ground monitors in unpopulated locations off the test site. On Highway 25, 14 miles east of Coyote Summit, approximately 20 miles off the test site, a gamma reading of 8 mR/hr was detected. The farthest ground level gamma radiation detected was near Pioche, Nevada at a level of 0.09 mR/hr. The highest external gamma dose rate recorded in a populated location was at Hiko, Nevada, at 1.5 mR/hr. Estimation of the infinite total whole-body exposure at this location is about 10 mR.

Air concentrations of iodine nuclides collected on an air filter at Hiko, Nevada, were documented as: 550 pCi/m^3 iodine-131, 800 pCi/m^3 iodine-133, 5,000 pCi/m^3 iodine-135, and 2,200 pCi/m^3 iodine-132. The highest gross beta air activity level detected in an offsite populated area was at Ash Springs, Nevada, with a value of 25,000 pCi/m^3 averaged over a period of 3-hours during which the high concentration occurred.

The highest value of radioiodine in milk was 4.8 nanocuries of iodine-131 per liter of milk from a sample collected at Hiko, Nevada. This is less than one-tenth of the Federal Radiation Council's guide for protective actions. Although the amount of iodine-131 present was only a small fraction of the FRC's Protective Action Guide, as a precautionary measure to avoid unnecessary exposures, the cows were placed on uncontaminated dry feed since it was readily available. The amount of iodine-131 in milk dropped from 4.8 nanocuries to 0.14 nanocuries in four days. The highest value for iodine-131 in milk in Utah and Idaho was 0.07 nanocuries per liter.

The actual amount of iodine-131 in human thyroids was determined by the U. S. Public Health Service, using a portable thyroid counter, for 71 children and 9 adults in the Nevada areas showing the highest levels of iodine activity in milk. The thyroid dose estimates ranged from 50 to 100 millirads for 14 individuals and to a maximum of 250 to 300 millirads for 5 individuals in the group. Additional intake of iodine-131 was expected from milk consumed after the time of thyroid dose. This maximum thyroid dose was considerably less than the Federal Radiation Council's Radiation Protection Guide of 1500 millirams per year for individuals in the general population.

DOUBLE PLAY TEST

This nuclear detonation was conducted in a tunnel complex, at a depth of 1075 feet, at the Nevada Test Site, at 1000 hours PDT, on June 15, 1966. The yield of this detonation was less than 20 Kt.

Immediately following the detonation radioactivity was released through the tunnel portal to the atmosphere. An estimate of the amount of radioactivity released as of R+12 hours is 750,000 curies. Aircraft tracking of the radioactive effluent cloud indicated a trajectory to the northeast. At a distance of about 200 miles from the test site the airborne cloud became so dispersed and diffused that further identification of airborne radioactivity became impossible.

Thirty-three air samples, one water sample, four milk samples and eighteen vegetation samples were collected in the offsite downwind area. These samples indicate no fresh fission products except for air samples collected at Alamo and Hiko, Nevada. Ground monitors detected no increase above the natural background radiation levels.

Analysis of the two air samples are:

Alamo, Nevada, $0710/_{15}$ to $0455/_{16}$	Gross beta	0.65	pCi/m^3.
	Iodine-131	0.87	"
	Iodine-133	0.57	"
	Iodine-135	2.2	"
Hiko, Nevada, $0720/_{15}$ to $0520/_{16}$	Gross beta	0.83	pCi/m^3.
	Iodine-131	1.9	"
	Iodine-133	1.2	"
	Iodine-135	5.6	"

DERRINGER TEST

This nuclear detonation was conducted at a depth of 835 feet. at the Nevada Test Site, at 0830 hours PDT, on September 12, 1966. The yield of this detonation was less than 20 Kt. An estimate of the radioactivity released to the atmosphere and remaining at R+12 hours is 12,000 curies. This release occurred because the closure mechanism on a Line-Of-Sight (LOS) pipe failed to function properly.

This radioactive cl~~oud was composed of~~ gaseous nuclides of krypton and xenon nuclides. At a distance of about 150 miles northeast of the test location, the radioactivity became so diffused and dispersed in the atmosphere it was no longer detectable.

In the offsite area, milk samples collected on September 13 and 15 at Alamo, Hiko and Nyala gave no indication of fresh fission products. Air and vegetation samples collected at eight offsite locations gave indication of traces of xenon nuclides. Two positive ground monitoring readings were recorded of less than twice background (0.05 mR/hr) in offsite unpopulated locations. These were Hancock Summit and 10 miles southeast of Coyote Summit.

NASH TEST

This nuclear detonation was conducted at a depth of 1,200 feet, at the Nevada Test Site, on January 19, 1967, at 0845 hours PST. The yield of this detonation was between 20 and 200 Kt. About twelve hours after the detonation, low levels of radiation were detected near the surface zero location. This seepage of gaseous radionuclides through the surface continued, at a diminishing rate, for a period of two days. An estimate of the total radioactivity released, based upon calculations of R+12 hour debris, is 69,000 curies. Analysis of this gaseous release indicated nuclides of xenon with a small quantity of krypton-88. The radioactive cloud associated with this seepage was tracked by aircraft to the southwest of the test site. Within a few miles off the NTS, the tracking aircraft could no longer detect the very low levels of radioactivity and all airborne contact with the cloud was lost.

In the offsite area a slight increase in background was noted on a gamma recorded near Lathrop Wells, Nevada. This increase was identified as about 0.14 mR/hr above normal background fluctuation. It should be noted that prior to this test small fluctuations above normal had been noted in the area around the NTS, as well as, the entire southwestern U. S. These fluctuations were caused by radioactive debris from the foreign atmospheric nuclear test conducted on December 27, 1966.

Air filters and milk samples collected in the offsite areas showed no fresh fission products above the fluctuating low levels that had previously been identified as debris from a foreign atmospheric nuclear test.

UMBER TEST

This nuclear detonation was conducted at a depth of 1,020 feet, on June 29, 1967, at 0425 hours PDT, at the Nevada Test Site. The yield of this detonation was less than 20 Kt. Radioactivity was-released to the atmosphere at the time of detonation through the LOS pipe which, as a result of the ground shock at shot time, was broken below the closure mechanism, thus, permitting seepage of radioactive gases through the soil to the surface. The best estimate of the quantity of gaseous nuclides released and remaining at R+12 hours is 26,000 curies. The radioactive cloud was tracked to the south southwest by aircraft. At a distance of about 90 to 100 miles from the point of release, the airborne radioactivity became so dispersed and diffused that the sensitive instruments in the aircraft could no longer detect it.

The maximum net gamma dose rate observed was 0.7 mR/hr at the junction of Highway 95 and State Road 16 (Ash Meadows turn off) at 0700 hours. Three charcoal cartridges from air samplers located at Death Valley Junction, California; Lathrop Wells, Nevada and ten miles east of Lathrop Wells showed small quantities (less than 80 pCi/m^3) of iodine-133 and iodine-135. No iodine-131 was detected. The gamma dose rate recorders at Death Valley Junction and Shoshone, California, showed a slight rise above normal background fluctuations. No fresh fission products were detected in milk, water, or vegetation samples.

DOOR MIST TEST

This nuclear detonation was conducted on August 31, 1967, in a tunnel complex at a depth of 1465 feet, at the Nevada Test Site, at 0930 hours PDT. The explosive yield was less than 20 Kt. About fifty-five minutes after the detonation a seepage of radioactivity from the tunnel portal occurred. The calculated quantity of radioactivity released to the atmosphere and remaining at R+12 hours was 400,000 curies. Gammaray energy spectra of the direct cloud emission showed the cloud was composed of gaseous nuclides primarily krypton-88, iodine-135 and xenon-135.

Aircraft tracking of the radioactive effluent cloud off the Nevada Test Site, to the north, indicated only sporadic and discontinuous contact with the airborne effluent. The cloud became so diffused and dispersed that detection of the airborne effluent using very sensitive radiation detection instruments in the aircraft was completely lost at a distance of about 60 miles from the shot location.

Analysis of air filters collected at ground location offsite revealed only one filter containing fresh fission products. This was at Diablo, Nevada. Levels of 2 pCi/m^3 of iodine-133 and 135 were recorded. There was no iodine-131 detected in offsite air filters or on vegetation samples collected in several offsite locations.

The highest offsite gamma radiation level detected by ground monitors was at Diablo, Nevada, where levels of 0.01 mR/hr were recorded. No radioactivity was detected in milk samples.

HUPMOBILE TEST

This nuclear detonation was conducted at a depth of 810 feet, on January 18, 1968, at 0830 hours PST, at the Nevada Test Site. The yield of this detonation was less than 20 Kt.

About one minute after the detonation, radioactivity was released to the atmosphere through a LOS pipe which did not properly close, however, this release was stopped about 20 minutes later when the surface collapse occurred sealing off the LOS pipe. The calculated quantity of radioactivity released as of R+12 hours is 120,000 curies. Analysis of air samples taken near the area where the release occurred, indicated the presence of volatile gases only, primarily iodine and daughters of fission products.

The airborne radioactive effluent was carried to the southwest. Aircraft tracking the effluent cloud lost contact over the southern portion of Death Valley in California and were unable to detect airborne radioactivity past that location.

The maximum observed ground monitoring reading was 0.7 mR/hr gross gamma at 1145 hours, near Dansby's Ranch, 4 miles west of Lathrop Wells on Highway 95. The maximum air activity level detected on a filter was at Dansby's Ranch in the Amargosa Farm area about 50 miles south of the Nevada Test Site. Levels of 1100 pCi/m^3 gross beta, plus 83 pCi/m^3 of iodine-133 and 1600 pCi/m^3 of iodine-135, were detected on an air filter collected between 0935 and 1745 hours on January 18, 1968.

Dosimeters placed at several locations downwind recorded no gamma exposures above natural background. Of the 45 milk samples collected from 16 stations, only 3 stations showed fresh fission products in 4 samples. These samples were collected at three ranches in the Amargosa Farm area. The maximum iodine-131 concentration in milk was 30 pCi/m^3.

POD TEST

This nuclear detonation was conducted at a depth of about 1,000 feet, at the Nevada Test Site, at 1200 hours PST, October 29, 1969. The yield of this detonation was between 20 and 200 Kt. It is estimated that 4,000 curies were released, calculated at R+12 hours. The cloud was tracked by aircraft to the south of the test site to a distance of about 35 miles from the shot location where the cloud became so diffused and dispersed that detection of airborne radioactivity was no longer possible.

The radionuclides identified were the nuclides of xenon and cesium-138. The maximum levels of radioactivity measured by ground monitors off the Nevada Test Site were reported to be two to three times background radiation or about 0.06 mR/hr. All samples of milk, water, vegetation and air filters analyzed to date have shown no radioactivity due to fresh fission products.

SNUBBER TEST

This nuclear detonation was conducted at the Nevada Test Site, at a depth of 1125 feet, at 0630 hours PST, on April 21, 1970. The explosive yield was less than 20 Kt. Gaseous radioactivity seeped to the atmosphere through the stemming material in the emplacement shaft. It is estimated that about 54,800 curies of activity calculated at R+12 hours were released. The radioactive effluent cloud was tracked to the northeast by aircraft to a location about 90 miles from the surface ground zero, where bad weather conditions were encountered requiring termination of aerial tracking.

On the ground the radioactivity was detected offsite by monitors southwest of Highway 25 on Valley Road and along Highway 25 from 12 miles northwest of Coyote Summit to 9 miles southeast of Coyote Summit. The maximum offsite reading was at Coyote Summit. Levels at this location increased above background at 0920 hours, peaked at 0945 hours with a reading of 0.6 mR/hr and returned to background at 1025 hours. The net gamma exposure from the integration of these readings with time at this location was 0.15 mR. No radiation levels were detected by thermoluminescent dosimeters (TLD's).

The effluent trajectory predictions of the Environemental Science Services Administration indicated that the cloud turned near Lund and Ely, Nevada, during the afternoon of April 21 and travelled over the southwestern corner of Utah into the Grand Canyon area. Environmental monitoring and sampling along this trajectory on April 21, and 22 found no detectable event-related activity in milk, vegetation, or soil samples.

The only environmental samples containing test-related radioactivity were snow samples at two locations and air filters obtained at nine different locations. One snow sample collected at Sunnyside contained 500 pCi/l iodine-133 and 690 pCi/l iodine-135; and the other, 45 miles north of Hiko on Highway 38, contained 140 pCi/l iodine-133. The maximum air concentration detected at a populated location was at Koyne's Mill, Nevada, where 86 pCi/m^3 of iodine-133 and 2 pCi/m^3 of iodine-135 were measured. Air filters from the populated locations of Nyala, Lund, Sunnyside, Currant and Ely, Nevada indicated lesser quantities of radioiodine nuclides during cloud passage.

The radiation exposure to people in these locations were calculated to be well below currently accepted radiation protection guides specified by the Federal Radiation Council for normal peacetime operations.

MINT LEAF TEST

This nuclear detonation was conducted at 0830 hours PDT, on May 5, 1970, in a tunnel complex on the NTS. The nearest surface was 1,330 feet. This detonation was completely contained underground, however, on the day following the detonation (May 6, 1970), there was a controlled release of radioactivity through a tunnel ventilation system to enable reentry of workers. This resulted in the controlled release of about 395,000 curies of radioactive gases, principally xenon nuclides, to the atmosphere.

Winds near the surface, at the time this relase occurred, were to the east. A ground monitor located just off the test site, in an unpopulated location on Highway 25, about 45 miles from the tunnel portal, detected xenon-135, on an air filter. This concentration was calculated to be about 6,000 pCi/m^3. No radioactivity was detected in any other environmental samples taken in the offsite areas.

Since xenon-135 is a noble gas and the one detected ground level sample indicated very low concentration, it is concluded that no detectable exposure to offsite populations occurred from this release.

BANEBERRY TEST

This nuclear detonation was conducted at the Nevada Test Site, at 0730 PST, on December 18, 1970, in a vertical hole 910 feet deep. The explosive yield of this test was less than 20 Kt. All of the programmed operations proceeded normally until 3.5 minutes after the detonation when a release of radioactivity commenced from a fissure which opened up after the detonation at a distance of about 300 feet from the emplacement hole. This release continued over an extended period even after the commonly experienced surface collapse which occurred at 16.5 minutes after the detonation. This surface collapse was a normal and expected phenomenon. The effluent venting rate steadily decreased with time but visible vapor continued to emanate from the fissure for 24 hours after the detonation. It is estimated that about 3,000,000 curies of radioactivity at R+12 hours were released to the atmosphere.

Winds, at the time of this release, were generally to the north and northeast. As this effluent cloud moved away from the test site, winds at different altitudes dispersed this cloud over Nevada, Utah and Wyoming, with one small segment moving to California. Aircraft equipped with sensitive detection equipment tracked the main air mass until it broke up over central Wyoming and the radioactivity decreased to the point it could not be measured. The presence of the radioactive material was detected in environmental samples from central and northern Nevada and in most of the western United States.

The maximum estimated infinite external gamma exposure resulting from the cloud passage and deposition at a populated location (Clark Station with one resident) was 36 mR. The maximum concentration of iodine-131 found in milk was 810 pCi per liter at a ranch near Beatty, Nevada, about 40 miles from the surface ground zero. The highest estimated thyroid exposure from inhalation and milk ingestion was 130 millirem to a two-year-old child in the Beatty, Nevada area. Although the highest milk concentration represented a very small fraction of the FRC Protective Action Guide value, from December 31, 1970 through January 10, 1971, distribution of this milk was terminated as a precautionary measure.

Radioiodine from BANEBERRY was also detected by EPA in milk samples from five locations outside Nevada: Bakersfield, California; Jerome, Idaho; Powell and Laramie, Wyoming; and Mt. Pleasant, Utah. The highest levels found at these five locations were in commercial milk samples at Bakersfield, California, and Mt. Pleasant, Utah, where the peak iodine-131 concentration was 60 pCi per liter corresponding to a projected infant thyroid dose of less than 10 mrad. These estimated thyroid exposures are less than 10 percent of the FRC Radiation Protection Guides specified for normal peacetime operations.

After the Environmental Protection Agency had completed its environmental sampling program in the off-NTS area, it was learned that sheepherders in the area north of the Test Site, where radioactivity had been detected, were using melted snow as a source of drinking and cooking water. These sheepherders, during the weeks following this release, were in an area about 30 miles east of Eureka, Nevada, on Highway 50 south to Duckwater, Nevada.

Based on sampling results in the general area, on information obtained from 8 sheepherders about their location and water consumption, and on snowfall records, EPA estimates the dose to their thyroids from radioiodine at about 0.5 rad plus or minus a factor of 3. The large uncertainty in the estimate results from the fact that there is no detailed information on the radioactive contamination levels at the locations where these sheepherders were; the old snowpack was diluted by new and uncontaminated snow; and there is no information about the distribution of radioactivity at any depth in the snowpack.

In assessing the overall radiological consequences of this accidental release, the data indicate the radiation exposure to individuals within the general populations outside the Test Site did not exceed the Radiation Protection Guides recommended by the Federal Radiation Council for normal peacetime operations.

March 27, 1972

DIAGONAL LINE

This nuclear detonation occurred at the Nevada Test Site at 1215 hours November 24, 1971. The yield of this test was less than 20 kt.

Beginning at about 1500 hours seepage of low level radioactivity was detected at surface ground zero. Slightly elevated instrument readings were observed near surface ground zero for the next several hours, with a maximum reading of 150 mR/hour.

The total release of radioactivity to the environment as a result of this test was estimated to be 5,000 curies of activity calculated at the time of release plus 12 hours (R +12 hours). The radionuclides identified were rare gases and their decay products.

Low levels of radiation were detected by airborne radiation monitors at a point above 5 miles south of the junction of Highway 95 and State State Road 16. No radioactivity above normal background levels was detected offsite by ground monitoring teams or by the gamma rate recorder network. No air particulate samples contained groos beta activity above normal background levels, and no event-related activity was detected on air particulate filters. No special water, milk or other environmental samples were collected for this event.

Mr. ROGERS. Thank you very much, Dr. Kerr, for your statement. Now, the only figures I noticed in your statement were, I believe, that 900 people had been overexposed. You gave me in answer to the question that somewhere between 400,000 and 500,000 have been exposed to radiation.

Dr. KERR. We have the results of their film-badge readings. Some of those readings, of course, may be zero, possibly no exposure present.

Mr. ROGERS. Yes. Or, many who were exposed did not have badges; is that true?

Dr. KERR. Yes. As I explained, in the early operations, particularly with parties of visitors and troop participation such as the Desert Rock exercise, badges were not issued to all personnel. However, I believe from 1957 on all onsite personnel were badged that were associated with the AEC test operations.

Mr. ROGERS. Now, you discussed in some detail the 1951 to 1962 atmospheric testing. What about 1946 to 1951?

Dr. KERR. I will have to defer to some of my colleagues with longer memories than mine.

Mr. ROGERS. We have no records of that? Do we have to go on memory, or are there records of that?

Dr. KERR. I am informed that our REECO records in Nevada include the Trinity test, and the Cross-Roads test program, and Sandstone. I cannot testify today with respect to the completeness of those records, only to the fact that we have records of individuals who were exposed on those tests.

Mr. ROGERS. Do you have an approximate estimate of the number involved?

Dr. KERR. Of the number involved?

Mr. ROGERS. Of the number involved in those tests, 1946 to 1951? Does anybody know that? In other words, the figures you gave us were from 1951 to 1962, as I understood it.

Dr. KERR. That is correct.

Mr. ROGERS. Between 400,000 to 500,000 exposed during that period of time.

Dr. KERR. When I answered your question earlier in the testimony, what I said was that our exposure records cover testing years from 1945 to the present; and the numbers of 347,640, and 110,650 are for that entire period.

Mr. ROGERS. For the whole period.

Dr. KERR. Yes, sir.

Mr. ROGERS. And you can give me the breakdown, I believe you said, from 1946 to 1951?

Dr. KERR. I have it broken down by year from 1945 through 1976, and split between on-continent and Pacific.

Mr. ROGERS. Could you give us that quickly, and then put it in the record?

Dr. KERR. And then submit it for the record? For example, on-continent 1945, 800 dosimetry records; 1946 on-continent 150, in the Pacific 11,500; 1947 on-continent 25, zero in the Pacific; 1948 zero on-continent, 1,500 in the Pacific; no exposure records from 1949 and 1950. In 1951 6,000 on-continent, 3,600 in the Pacific.

[The list referred to follows:]

DOE/NV PERSONNEL DOSIMETRY RECORDS BY LOCATION & YEAR*

(Rounded off to nearest hundred in most cases)

YEAR	CONTINENT	PACIFIC
1945	800	0
1946	150	11,500
1947	25	0
1948	0	1,500
1949	0	0
1950	0	0
1951	6,000	3,600
1952	2,800	2,300
1953	3,900	900
1954	265	12,700
1955	4,100	2,900
1956	900	20,500
1957	29,500	1,100
1958	8,600	27,500
1959	7,100	500
1960	5,800	50
1961	12,100	0
1962	6,100	25,600
1963	18,800	0
1964	21,300	0
1965	21,500	0
1966	22,200	0
1967	19,500	0
1968	19,000	0
1969	17,000	0
1970	14,100	0
1971	12,000	0
1972	19,600	0
1973	19,300	0
1974	19,100	0
1975	19,300	0
1976	16,800	0

*Includes multiple entries for some personnel in some years on the continent prior to 1957 and in the Pacific.

EXHIBIT I.

NUMBERS OF PERSONNEL DOSIMETRY RECORDS FOR PACIFIC AND CONTINENT NUCLEAR TESTS

Mr. **Rogers.** Were there any tests in the 2 years that you have no records?

Dr. **Kerr.** No, sir.

Mr. **Rogers.** No tests.

Dr. **Kerr.** No.

Mr. **Rogers.** I notice you mentioned Baneberry, what has been the incidence of disease and death of those that were exposed there?

Dr. **Kerr.** It is my understanding that there are two individuals with exposures to Baneberry who are now dead.

Mr. **Rogers.** Do we know from what?

Dr. **Kerr.** I believe both individuals died of leukemia.

Mr. **Rogers.** Both died of leukemia. And what were their radiation exposure records?

Dr. **Kerr.** We have their exposure records, and neither exposure was in excess of the guidelines.

Mr. **Rogers.** Neither was. What was the guideline, then?

Dr. **Kerr.** The guideline in effect at the time was 3 rem per quarter.

Mr. **Rogers.** Per quarter?

Dr. **Kerr.** Yes, sir.

Mr. **Rogers.** What is the current guideline?

Dr. **Kerr.** It remains 3 rem per 13-week period.

Mr. **Rogers.** Dr. Carter?

Mr. **Carter.** As a usual thing, did you not have people who were specially equipped to go ino that area to see if it was safe for the troops to come in?

Dr. **Kerr.** Well, we are talking of Baneberry.

Mr. **Carter.** I know. I am asking you about another area.

Dr. **Kerr.** Yes. Let me speak to two different things in my answer, the first being the AEC participation in the weapons tests. Radiological safety monitors accompanied the re-entry team when the on-site technical people went back to get their data or instruments. They are the ones that determine it is safe for the re-entry to take place.

With respect to the DOD participation in the Desert Rock exercise, as you recall, they were providing their own radiological safety and monitors for their operation.

Mr. **Carter.** And at that time the level at which they permitted the troops to go in was what? Was it five-tenths of a rem, or 500 Mrem.

Dr. **Kerr.** I do not feel that I can testify. From personal knowledge I do not know; and second, I think it is the DOD's responsibility.

Mr. **Carter.** Now, about Baneberry, do we not know that actually three people have leukemia of 13 guards who were there. Is that not correct?

Dr. **Kerr.** I believe one of the individuals was not a security guard.

Mr. **Carter.** Well, he was there anyway, whether he was a security guard, a member of AEC, or whatever?

Dr. **Kerr.** I was just for completeness mentioning it.

Mr. **Carter.** Thank you, Mr. Chairman.

Mr. ROGERS. Thank you. We have been advised that three men died of leukemia; is that correct?

Dr. KERR. Yes, sir; that is correct. I was in error in my first answer.

Mr. ROGERS. Have we checked it, do we know?

Dr. KERR. We know.

Mr. ROGERS. Have there been any others reported with leukemia?

Dr. KERR. From the Baneberry venting?

Mr. ROGERS. Yes.

Dr. KERR. Not to my knowledge.

Mr. ROGERS. Now, what about the followup studies of the men who were at Baneberry, those at the camp; has there been a followup?

Dr. KERR. There has been an extensive followup. Let me turn to my record of it, so it will be a complete answer.

Mr. ROGERS. Could you tell us about how many were in the camp that were exposed?

Dr. KERR. There were approximately 900 people of which 86 were found to have small amounts of radioactivity on them when they passed through a monitoring station. The final analysis indicated that no one received exposures that exceeded the radiation concentration guidelines, 3 rem per quarter whole body for occupational workers. Most of these people received less than one-tenth that value.

In order to address the question of external and internal exposure, those 86 were taken to Las Vegas where the Environmental Protection Agency has a whole-body counter. In fact, it was determined through those measurements that they had not received internal exposures of any nature not already recorded through their external exposure reading from their film badge.

Mr. ROGERS. Have their medical records been checked within the last year?

Dr. KERR. No, sir, they have not.

Mr. ROGERS. Well, do we know what is happening to them?

Dr. KERR. I can explain the procedure. For those who are still Department of Energy employees or contractor employees, there is a continued followup through the industrial health and safety program that we require of our contractors. In the event someone leaves the employment of the department of one of its contractors, at the present time there is not a followup required.

Mr. ROGERS. And who are your contractors involved here?

Dr. KERR. The principal ones for the Nevada test site are the Reynolds Electrical and Engineering Co. for construction and maintenance; E.G. & G., Inc., which provides technical diagnostic measurement support; Holmes & Narver, Architect Engineers; Fenix & Scissin for mining engineering; Wackenhut for security services, and then personnel from the three weapons laboratories at Los Alamos, Livermore, and Sandia Laboratories in Albuqerque.

Mr. ROGERS. In other words, the contractor assumes the responsibility.

Dr. KERR. The contractor is required to be responsible and is appraised in his performance by Government employees.

Mr. ROGERS. For what period of time?

Dr. **Kerr**. Continuously. As long as anyone is employed in an area of their operations where they may be exposed to radiation.

Mr. **Rogers**. And do they make reports to you?

Dr. **Kerr**. Yes.

Mr. **Rogers**. Do you have those reports?

Dr. **Kerr**. The appraisals of the contractors?

Mr. **Rogers**. Yes.

Dr. **Kerr**. Yes. In fact, in my prior position as deputy manager of Nevada operations I was the person who received the reports on the performance of the contractors.

Mr. **Rogers**. So, these are reports on followups.

Dr. **Kerr**. These are reports of how the contractor is doing his job in keeping records, in following up problems, and implementing——

Mr. **Rogers**. No, that is not what I asked. I am not asking for a report on what they are reporting and their technique. I am asking you if they report to you the actual health status followup on the people involved in Baneberry.

Dr. **Kerr**. They do not report to me by name the individual cases. The way in which that works is that a man's supervisor receives the report of his radiation exposure. It is then his responsibility, if a guideline has been exceeded, or one is approaching a guideline, to assign that employee to work in an area where he will not get further exposure and exceed the guideline. The employee is to be notified by his supervisor.

Mr. **Rogers**. Do you have present followup procedures on these people, the 900?

Dr. **Kerr**. If I understand your question correctly you are asking, do we follow people after they leave employment?

Mr. **Rogers**. Yes.

Dr. **Kerr**. The answer to that is, no.

Mr. **Rogers**. You do not. Now, suppose some of the 900 did not have what we considered overexposure as of that time, but their exposure was beyond what we permit now. In other words, today we would not permit the exposures that they were then permitted to receive.

Dr. **Kerr**. Those that exceeded the guidelines we would, I think, today make every attempt to keep them from overexposure.

Mr. **Rogers**. Well, what is your guideline today? The guideline is not 3 rem per quarter, is it?

Dr. **Kerr**. Yes, sir.

Mr. **Rogers**. It is still 3 rem per quarter?

Dr. **Kerr**. That is correct.

Mr. **Carter**. Mr. Chairman if you would yield on that.

Mr. **Rogers**. Yes.

Mr. **Carter**. What is the guideline for a day? A quarter is 3 months, we want to know what it is for one exposure.

Dr. **Kerr**. Well, sir, it is 3 rem per quarter and 5 rem per year. So, if you ask what it could be for one exposure, it could be 5 rem. But then it would be your responsibility to keep that employee out of a radiation field for the rest of the year, a year from that point.

Mr. **Rogers**. All right, let's assume no one exceeded the 3 rem per quarter. But suppose one of these developed leukemia or another illness, but you do not follow him if it has not exceeded the exposure. Is that right?

Dr. KERR. No, sir. The answer that I gave you was that we do not follow him after he leaves the employment of the Government or one of the contractors.

Mr. ROGERS. Suppose he is still hired by the contractor, what happens if he becomes ill? The radiation shows he was not exposed to over 3 rem within the quarter; what happens?

Dr. KERR. If you are asking me the question, do we try to relate exposure to illness, I think what you are doing is asking the question your committee is trying to address, that is, to this point in time the informed scientific opinion that has led to the guidelines under which we operate has been that these guidelines are such that exposures will not result in illness from radiation exposure. Should that opinion change, the guidelines would change and we would be operating under different procedures.

Mr. ROGERS. Well, the point is that you are not trying to gather the information to find that out, to make a proper scientific judgment.

Dr. KERR. Let me defer now—I have testified to you prinicipally on the operational matter—Mr. Hollister can speak to you a bit about what the Department does do in studying the health effects of radiation.

Mr. ROGERS. I think Dr. Carter has a question.

Mr. CARTER. Yes, sir. I would like to know what the film badges of those three men who died of leukemia showed. Can you give me the readings on those badges please, sir?

Dr. KERR. The highest of the three was 980 millirems, that is less than 1 rem.

Mr. CARTER. That is 0.98 rem. We do not consider that significant, really, since it is not up to 3 rem's per quarter or 5 rem's per year; and yet, we have a man dying of leukemia.

Now, we have one man at 0.98 rem. What were the other two who died?

Dr. KERR. I do not know exactly. We have the records on them, I do not know what they were exactly, but they were less than the 980 Mrem.

Mr. CARTER. They were less than that.

Dr. KERR. Yes, sir.

Mr. CARTER. Well, this again shows that our exposure guidelines are suspect. We have set a level for what we believe is safe. You said that 5 rem was permissible in one exposure. So, three of these men were 0.98 rem, or 980 millirem or less each, and yet each died of leukemia.

Now, what has been done about these men, have they been compensated? Who will compensate them, will that be done by AEC or REECO?

Dr. KERR. There is litigation at present, which is being handled by the Department of Justice. There are claims against the Government for those cases.

Mr. CARTER. Is there any doubt in your mind but that those men died as a result of their exposure to radiation at Baneberry?

Dr. KERR. It is not appropriate for me to answer that question because of the litigation.

Mr. **Carter.** It's not appropriate for you to answer?

Dr. **Kerr.** I have been advised that I can say one thing further, and that is, our medical witnesses will testify to the effect that in their opinion those deaths could not have been caused by the exposures on Baneberry.

Mr. **Carter.** That what?

Dr. **Kerr.** That in their opinion those deaths could not have been caused by the Baneberry exposures.

Mr. **Carter.** Where do you get witnesses who are going to offer testimony such as that?

Dr. **Kerr.** From the community which is presently thought to have the most extensive knowledge.

Mr. **Carter.** I disagree with you entirely on that, sir.

Mr. **Rogers.** May I ask this, now, you were going to tell us, I believe, what you do and how you determine whether anyone else is affected, even though they may not have received the 3 rem radiation exposure in the 3-month period. I believe you started to address that.

Mr. **Hollister.** Mr. Chairman, I am not quite sure what the question is on the table, but let me make a couple of comments.

Mr. **Rogers.** All right.

Mr. **Hollister.** First of all, the Department has and has had—its predecessor agencies have had—an extensive research program devoted to answering such questions as what the health effects of ionizing radiation, especially low doses, are. There is a very extensive program which the Congress has funded for perhaps a quarter of a century.

Mr. **Rogers.** And it is in your jurisdiction mainly, is it not?

Mr. **Hollister.** Not in my personal jurisdiction, it is in Dr. Liverman's jurisdiction; yes.

Mr. **Rogers.** And he was in the AEC before he was in ERDA.

Mr. **Hollister.** The program was in AEC and Dr. Liverman at one time was at AEC.

Mr. **Rogers.** And then he headed it up in ERDA; did he not?

Mr. **Hollister.** And then he headed it up in ERDA.

Mr. **Rogers.** And now he is heading it up in DOE.

Mr. **Hollister.** He is the assistant secretary-level person responsible for the biomedical research program; yes, sir.

Mr. **Rogers.** And the suits are being brought against whom?

Dr. **Kerr.** The suits are being brought against the U.S. Government.

Mr. **Rogers.** For actions of whom, AEC, ERDA, and DOE; is that right?

Dr. **Kerr.** I think the specific action on that is for acts attributed to the Government and its contractors.

Mr. **Rogers.** Well, I understand, but it was under the control—these safety programs on exposure—of AEC, ERDA, and now the DOE, the successor agency. And you are doing the research—you have most of the funds for doing research to determine a safe radiation level; and then your medical witnesses go in and say, "We do not have any responsibility."

Mr. **Hollister.** Can I respond to that, sir?

Mr. **Rogers.** Yes.

Mr. Hollister. There is a very long pathway between the carrying out of biomedical research and the establishment of radiation protection guidance, and finally the interpretation of that radiation protection guidance into operational procedures at such places as the Nevada test site. The main purpose of a research program—any research program—is to find out the facts, find out information, obtain understanding. That material so obtained with the funds is published in suitable journals, referee journals and the like, and becomes available to the scientific community as a whole.

Now, there are specialized bodies, many of them nongovernmental, such as the National Committee on Radiation Protection, such as the International Commission on Radiological Protection, bodies who do among other things put teams of people together to try to assess what these research findings mean in terms of practical radiation protection guidance. They publish public bulletins, and booklets, and technical reports of various kinds. These reports are not in themselves research findings, they are assessments, judgments, if you will, that are based on research findings; and they codify basic radiation protection guidelines.

Then the Federal agencies, such as AEC, ERDA, DOE, but also any other Federal agency that must carry out activities involving radiation protection, such as the Nuclear Regulatory Commission, they must take this basic advisory guidance, if you will, and translate it to operational criteria and codes which the operations are then bound to follow as best they can.

Mr. Rogers. But none of the research has yet answered the question whether low-level radiation causes cancer; is that what you are telling me?

Mr. Hollister. I have experts here who can state this better than I can. I think Mr. Kerr's statement has summarized it very well. The present position is that if you wish no risk at all, the only way to be assured of that is have no exposure at all. All exposure carries some risk.

Mr. Rogers. There is a call to the floor, we will have to recess for 10 minutes. The committee stands in recess.

[Brief recess.]

Mr. Rogers. The subcommittee will come to order, please.

Doctor, I guess DOE has the major radiation health effects research responsibility, does it not?

Dr. Kerr. DOE has a large program. I am personally not responsible for it and defer to Hal Hollister to speak to that.

Mr. Hollister. Dr. Liverman, as the Acting Assistant Secretary for the Environment——

Mr. Rogers. What is the DOE budget for research on health effects of radiation?

Mr. Hollister. ~~I am told~~ that it is about $65 million. If that is substantially incorrect, we will correct it for the record. But not all of that is for research related to nuclear energy. We have some research that is related to the Department of Energy's other energy technologies.

Mr. Rogers. What I am asking is, what portion of the budget is allocated for radiological health effects research, radiation health effects research?

Mr. Hollister. I am told that about $13 million is allocated specifically to health effects research of ionizing radiation, human health effects.

Mr. Rogers. And how is that being spent?

Mr. Hollister. I would like to ask for help on this from Dr. William Burr who was introduced to you as the Deputy Director of the Biomedical Research Division.

Mr. Rogers. Certainly. Pull your chair up to the table.

Dr. Burr. In the human health area we have, of course, the work in Japan, the followup studies of the Japanese.

Mr. Rogers. That comes out of your budget?

Dr. Burr. Approximately $6 million.

Mr. Rogers. And that is the largest?

Dr. Burr. That is the largest single item.

Mr. Rogers. How else is your research money being spent?

Dr. Burr. Then we have followup studies on workers that you are aware of, the studies Dr. Mancuso had initiated; and these are being continued in Oak Ridge. That is about half a million dollars, something in that neighborhood.

Mr. Rogers. How much?

Dr. Burr. A half a million.

Mr. Rogers. Half a million on which study?

Dr. Burr. Oak Ridge. The followup on workers of Hanford and Oak Ridge total $700 thousand.

Mr. Rogers. Hanford and Oak Ridge. How many people were involved in that?

Dr. Burr. Approximately 150,000, something like that, in the two studies combined.

Mr. Rogers. All right, and what else?

Dr. Burr. Then we have a transuranium registry which is about a quarter of a million dollars.

Mr. Rogers. Is that voluntary?

Dr. Burr. Yes, sir, that is voluntary.

Mr. Rogers. So, you do not know whether you are getting all the records or not, it is whoever wants to participate?

Dr. Burr. Yes, sir, it depends on the willingness of the worker to participate in the study.

Mr. Rogers. And there you are spending a quarter of a million dollars.

Dr. Burr. Yes, sir, about that.

Mr. Rogers. I presume that is not so much research as the actual receiving of the records, is it not? Are you doing any research as such, or just receiving and storing the records?

Dr. Burr. It is a study, a registry, first of all, of the people that are willing to be enrolled who have or have had the potential for exposure to transuranium elements. Second, it is an opportunity to study tissues of some of them at the time of death. It is a way of correlating tissue deposition, the distribution in the body, with the measurements we make in the whole-body counter and by other measurement techniques.

Mr. Rogers. In other words, you are waiting for them to die to compare.

Dr. Burr. In that particular study, that is true. We also have a new study at the Los Alamos Laboratory which is a followup of individuals who have worked with transuranium elements. That is a fairly new study.

Mr. ROGERS. When was that initiated?

Dr. BURR. Approximately 4 years ago. I will correct that for the record if it is not accurate.

Mr. ROGERS. How many are involved in the study?

Dr. BURR. About 12,000 workers.

Mr. ROGERS. And they were exposed where?

Dr. BURR. The largest number in this group comes from Hanford, but we are looking at all sites that were in the AEC operations where there was the potential for exposure.

Mr. ROGERS. Are these people the 12,000 whose records indicate they were overexposed?

Dr. BURR. No, just that they had an opportunity for exposure.

Mr. ROGERS. An opportunity. Was there any indication that they received any radiation?

Dr. BURR. In some cases there are tests which indicate that they have, sir, in the way of analysis of urine, or other tests. What we are talking about here is really an internal emitter, and the film badge per se would not help you. These people of course were badged for external radiation as well.

Mr. ROGERS. But this is for internal, the alpha?

Dr. BURR. The transuranium elements; yes, the concern is the alpha emitter, and our concern is with internal deposition.

Mr. ROGERS. And how much is being spent on the Los Alamos study?

Dr. BURR. This is approximately half a million dollars, also.

Mr. ROGERS. All right, what else, now?

Dr. BURR. We have followup studies of the Marshallese who were accidentally exposed from the Bravo shot on Rongelap and Rongerik. These are medical followup studies of individuals.

Mr. ROGERS. How many are involved there?

Dr. BURR. There were approximately 200 individuals.

Mr. ROGERS. Were these individuals actually exposed, overexposed beyond the limit?

Dr. BURR. There is of course a control population as well as the exposed population. But the individuals on Rongelap were exposed.

Mr. ROGERS. What about Uterik Island?

Dr. BURR. Uterik as well.

Mr. CARTER. Mr. Chairman?

Mr. ROGERS. Yes, Dr. Carter?

Mr. CARTER. Was this a direct exposure or was it from fallout?

Dr. BURR. This was from fallout.

Mr. CARTER. Thank you, sir.

Mr. ROGERS. How much is being spent on that study?

Dr. BURR. This runs around half a million dollars.

Mr. ROGERS. Any other studies?

Dr. BURR. Yes, sir, we have followup studies on radium workers. This work has been going on for many years and it is a study which includes individuals who tipped the brushes with their tongues when they painted the watch dials.

Mr. ROGERS. How many are involved in this study?

Dr. BURR. I think there are between 1,500 and 2,000 individuals.

Mr. ROGERS. And how much money is going into this study?

Dr. BURR. This is about $2.6 million. The results of the radium study were used as a benchmark to set early standards for bone-seeking radionuclides in the body that we base standards on.

Mr. ROGERS. Any other studies?

Dr. BURR. I cannot think of any large population studies. I will be glad to assigment this information for the record.

Mr. ROGERS. Yes, if you would, for the record.

Dr. BURR. And I will give you the actual figures.

Now, in addition to the human health studies we do have what we term health effect studies on animal systems, or on biological systems, which are studies that would involve animals; they might involve plants; they might involve subcellular systems, particular studies looking for effects that may be associated with radiation.

Mr. ROGERS. Why have no studies been done on the atomic tests, the blasts where the troops were involved; why have no health effects studies been done on that?

Dr. BURR. Why were they not done, is that the question?

Mr. ROGERS. Yes.

Dr. BURR. Well, until this was brought to our attention we felt that the exposures that individuals were receiving were not likely to show any biological effects. As Mr. Hollister has pointed out, we believe it is prudent to accept that there may be some risk, some degree of risk with any exposure. However, standards are set at a level where you would not expect to have an unacceptable risk. Therefore, if a population is below that, you really would not anticipate that you would see much in following the population.

Most of the human data we have, we have gained from the studies in Japan where the exposure was very much higher; and even there we do not have much information where exposures were low.

Mr. ROGERS. Well, the exposure there was so high, I presume, was it not?

Dr. BURR. But there are groups that were farther from the device that had very low exposures. We look at those groups as well.

Mr. ROGERS. But you have not followed up, really, on Baneberry?

Dr. BURR. We do not have a followup study.

Mr. ROGERS. Nancy, where they got up to 14 rem exposure?

Dr. BURR. No, sir, we do not.

Mr. ROGERS. Now, how are you going to make the judgment unless you study these people who were exposed at low levels? What chance is there that current scientific opinion of what is safe will ever change unless you do the necessary research? I do not know how you can continue to follow current opinion when you know, the scientific community has looked only at high levels of radiation. Oh, there have been a few studies, but we have seen now that some of the scientists very definitely say—in fact we had them before this committee—that without question low-level radiation has adverse effects on human health. And yet, in research, where DOE has the responsibility, it does not seem to carry that out.

Well, now, if we leave it in your hands to do that, I do not think we will ever find out because you do not want to look at anybody below the level of exposure.

Dr. BURR. No; that is not quite true.

Mr. ROGERS. Well, from your studies here it looks like it to me.

Dr. **Burr**. There is one study I mentioned which was a followup study of workers at Hanford and Oak Ridge. These workers were not expected to get exposures above the standard.

Mr. **Rogers**. Yes; but you were looking at alpha radiation there.

Dr. **Burr**. No; in those we are looking at total exposure. The transuranium studies are with alpha. The studies in the Hanford and the Oak Ridge population, include any exposure to radiation.

Mr. **Rogers**. And how many are involved in that?

Dr. **Burr**. That is the one we said is around 150,000.

Mr. **Rogers**. About 150,000. Now, why have you not followed up with the nuclear test participants where you have large populations there, more than 500,000 people?

Dr. **Kerr**. I think the answer to that is, with respect to the Hanford and Oak Ridge population, the AEC and now the Department of Energy has cognizance of those facilities, and was responsible for the radiological safety and protection of those workers.

In the case of the Desert Rock troops, as you have determined earlier in your investigation, we were not responsible for their radiological safety, nor for their records. And the completeness is not as suitable for the technical study.

Mr. **Rogers**. Well, that is what concerns me. You say DOE has the responsibility for health effects research, but you say the troops health condition is the Department of Defense's responsibility' that you are just going to look at some people who worked in DOE plants. That is my concern and this committee's concern that we are not doing proper research to determine possible health effects.

Now, let me ask you this, you said—and it was stated in the record—that the local commander, or the commander running the test could vary the exposure standards. I would like for our records to have all of the tests set forth and the standards that were used, accepted standard set forth by AEC, the actual standards used at the blasts. Would you let us have that for the record?

Dr. **Kerr**. Yes, sir, we will [see topic A-2 of DOE responses p. 440]. Further, when I answered that question when you asked me about it before I pointed out that the AEC test manager would on rare instances authorize this exposure in excess for specific people. These were people, for example, who had to re-enter instrument stations to recover film or data, that film being perishable if it is left in a radiation field.

Another exception would be for pilots flying sampling aircraft who, from time to time would exceed—and would be authorized to exceed. At no time did the AEC test manager take responsibility for authorizing large numbers of troop exposures in excess of guidelines. Among other reasons, he was not responsible for their activity.

Mr. **Rogers**. The AEC may not have, but you permitted, and the Defense Department told us they had the AEC as their advisers, you permitted the troop commander to vary that.

Dr. **Kerr**. No, sir. What I testified to was the fact that, for example at Plumbbob the Department of Defense at its own request had responsiblity for the radiological safety of its people.

Mr. **Rogers**. I understand that. What I am saying is, they also had the advice from AEC as to what the standards should be; did they not? That is what the Defense Department testified.

Dr. **Kerr**. The AEC and the defense Department had the same national standard for radiation exposure as their guide.

Mr. **Rogers**. Well, that is not what they told us yesterday, they had a different standard. In fact, they went up as much as 10 rem per year, not 5.

Dr. **Kerr**. Well, I have testified, sir, as to the arrangements under which radiological safety was handled on those tests. Should the DOD memories or records differ, I would be happy to examine that with you.

Mr. **Rogers**. Well, it is in the testimony, it was testified to yesterday by Mr. Haas, the Deputy Director of DNA. I thought you had observers here yesterday.

Dr. **Kerr**. I was present, sir.

Mr. **Rogers**. You did not hear that?

Dr. **Kerr**. I did.

Mr. **Rogers**. Well, what is your testimony now?

Dr. **Kerr**. My testimony is as I gave it.

Mr. **Rogers**. Which is what, after you heard the Department of Defense testify yesterday what their standard was? I thought you just told us earlier that exposure standards you could vary. On page 12, if you will read the first sentence. In fact, I will read it for you.

> In the atmospheric testing period from 1951 to 1962 maximum permissible amounts of radiation exposure for test participants generally were established, or adopted prior to each nuclear testing operation by the test manager or the joint task force commander. However, permission was given by the test manager or the task force commander, for certain test participants to exceed the maximum permissible amounts. They performed critical assignments, cloud sampling, recovery of scientific instrumentation or data; they were not Desert Rock troops.

Dr. **Kerr**. That is exactly as I testified, sir.

Mr. **Rogers**. And that says you did allow a variance from the standard.

Dr. **Kerr**. That is correct, on an individual basis.

Mr. **Rogers**. And it was set by the test manager or the joint task force commander.

Dr. **Kerr**. That is correct.

Mr. **Rogers**. The joint task force commander probably had no expertise in radiation at all.

Dr. **Kerr**. Yes; but you will recall that he had the scientific deputy to advise him on these matters.

Mr. **Rogers**. And who was the scientific deputy?

Dr. **Kerr**. In general he was a civilian drawn from one of the then AEC weapons laboratories.

Mr. **Rogers**. That is exactly what I said, it was the AEC who was advising him, and they let him change the standard. They testified to that yesterday.

Dr. **Kerr**. For specific individuals performing specific tasks; that is correct.

Mr. **Rogers**. And we also heard that some of the troops were put in closer than they should have been, taken out of the trenches, put on the open ground, not back 1,500 feet or more from the blast.

Dr. **Kerr**. Sir, you may recall, though, that the Desert Rock troops were not under the scientific AEC test manager.

Mr. **Rogers**. That is what I am saying, that there was no AEC guideline adhered to, that you allowed the troop commanders to do it, on the advice they got from AEC. In other words, it was the troop commander who could do that.

Dr. **Kerr**. I am afraid, sir, in going through the testimony I may have confused you between the organization for a specific operation where you had a military joint task force commanded by a military officer and advised by a deputy, who was a scientific person drawn from the laboratory; and the on-continent organization where you had an AEC test manager. If we are talking about on-continent, that is the exposures of troops in trenches in Nevada, those individuals were under the command of the Desert Rock commander over whom the AEC test manager had no control.

Mr. **Rogers**. I understand he had no control, he only advised. I understand that.

Dr. **Kerr**. No, sir; he did not advise in that instance.

Mr. **Rogers**. You told me that the AEC had a deputy scientific advisor who normally was a civilian.

Dr. **Kerr**. In the off-continent programs.

Mr. **Rogers**. So, AEC did not give any advice in the Nevada testing, are you telling me that?

Dr. **Kerr**. I will re-read the part of my testimony that addresses this.

Mr. **Rogers**. You do not know?

Dr. **Kerr**. Beginning in 1953, and continuing through 1957, the AEC at the request of the DOD delegated responsibility for the radiological safety of troops to Defense. During those latter years——

Mr. **Rogers**. I realize that. Let me interrupt you. I understand you did not have the responsibility, Doctor. I am saying, you still advised the Defense Department because you were the agency in the Federal Government that knew about radiation damage. Are you telling me now you did not advise them? I understand you did not have control of the troops, but are you telling me now that the commander did not get advice from AEC?

Mr. **Hollister**. Mr. Chairman, could I respond to that question and comment on it?

Mr. **Rogers**. Yes, you may, certainly.

Mr. **Hollister**. And again, we may have to do some shoring up for the record. I think the problem is that we are proceeding too directly from what goes on in research to what goes on in operations. The point I tried to make just before the break was that there is an enormous gap between what goes on in research, and what finally is carried out in operations.

I mentioned that we go from research to the literature; we go from the literature to the establishment of basic radiation protection criteria and standards, partly by government bodies such as the BEIR Committee under the National Academy of Sciences, partly by non-Government bodies that I named before. Now, when the basic radiation protection guidance is laid out for the protection of radiation workers, et cetera, those guidelines have to go through yet another step before a task force commander or somebody has something he can work with. That general guidance has to be translated into what I would call operational guidelines, or operational criteria—this is it.

At that point it is quite possible that one jurisdiction, namely the AEC Test Commander in Nevada, may go one way, and another jurisdiction, such as the Department of Defense Troop Commander, might go another way. Now, they have not changed the science; they have not changed the research results; they have not changed what the NCRP, or the ICRP, or the National Academy of Sciences has said, but they have changed the actual operational application of that guideline.

Mr. **Rogers**. That is exactly what I am saying, you did not make them adhere to any standard. AEC permitted a variance by the Defense Department from you normal standards. I do not know whether you did it just by an arrangement, you said you agreed to turn it over to them and let them do it. So, Defense could vary it, and you said your task commander could change the standard.

Mr. **Hollister**. Yes, sir, except I would change one part of that. I think in turning over the operational jurisdiction to the Department of Defense for the Desert Rock operations, the statement would be that the DOD was then given the authority and responsibility to establish their own standard, not to depart from our own operational standard.

Mr. **Rogers**. Well, I see no difference. If you let them do whatever they want to do, they are not adhering to your standards and you are the agency at the time that was supposed to set the standards of safety.

Mr. **Hollister**. Not for the military, sir.

Mr. **Rogers**. For anybody involved in tests.

Mr. **Hollister**. No, sir.

Mr. **Rogers**. You mean the advice, the scientific advice you gave had no effect, the standard that AEC set had no effect?

Mr. **Hollister**. Well, I think the Department of Defense has to answer that.

Mr. **Rogers**. Well, they did yesterday when they said they had a scientific adviser, usually a civilian, from AEC; but the troop commander could still vary the standard.

Well, I will not pursue that further at this point, we will later. Let me ask you this, you have a law suit pending against you on the Baneberry test. Have you done a study on those people yet, on all the rest of the 900?

Dr. **Kerr**. The answer to that, sir, is, no; we have not followed the entire population of 900.

Mr. **Rogers**. How can you find out, then, about possible low level radiation health effects?

Dr. **Kerr**. Well, the film badges that all 900 people were equipped with have been read and entered in their records. Those records are available, but the exposure levels are such that we are not presently, with the knowledge we have, concerned about health effects.

Mr. **Rogers**. But there is no medical followup.

Dr. **Kerr**. No, sir, that is not correct. To the degree that a large number of those people are still employed at the Nevada Test Site, their records are followed annually, and their radiation badges are read monthly.

Mr. **Rogers**. If they are still there. How many are still there?

Dr. **Kerr**. I cannot answer that at this point.

Mr. **Rogers**. Well, somebody must know. Surely, you are following that rather closely, if there are law suits involved. Does anybody know?

Dr. **Kerr**. Sir, we can supply that to you for the record.

[The information requested was not furnished by the Department at the time of printing.]

Mr. **Rogers**. That would be helpful if you would let us know how many are still there.

Dr. **Kerr**. With respect to those people that were found to have contamination, the 86 that I told you about earlier, those people were taken first to Mercury, where a thyroid count was done; and those who needed to be checked further, to Las Vegas, where a whole-body count was done to check on the question of whether they had an internal exposure. In no case did the measurements indicate that a medical problem would result, or a followup be required.

Mr. **Rogers**. But three have died from Leukemia. Does that indicate anything?

Dr. **Kerr**. It is presently the opinion of those more expert than I in this field that the leukemias did not result from the Baneberry exposure.

Mr. **Carter**. Had they eaten some chocolates, or something, that caused it? Mr. Chairman, that staggers the imagination.

Mr. **Rogers**. Well, I would like to ask you to supply to the committee a followup on those 900. You see, what we are concerned with, for instance on Smoky, the people who have the responsibility for the research and the Department of Defense took no action, for instance, on Smoky. It had to be activated by CDC, and then DOD began to show interest. And what has been done? Nothing. Nothing has been done. All on the basis that we looked at some badges and yet many never received badges at all—one per platoon. And then you say, we looked at the badges, and if they did not reach a level that those badges were supposed to show, then we have no concern.

Well, we will never find out if low-level radiation has any effect if we consistently refuse to do the necessary research on those who were actually exposed—and we have them here.

Now, it seems a strange thing to me—and does it not seem strange to you—that we will spend $6 million for followup on the Japanese, but we are not spending, basically, anything near that for followup on American soldiers who were used in these tests and exposed to radiation, and now we are having leukemia cases show up. Does it concern you that 8 cases out of that 500 that CDC has tracked down, now have leukemia? Does that maybe show that since you and the Army say, "Oh, well, the exposure did not go above what it was supposed to" that this maybe means that low-level exposure does have some effect? Is that a normal rate for leukemia in that group? What would you think?

Dr. **Kerr**. I cannot help but agree with you, sir, as an individual and as someone representing the Department. I think it is important that we understand these things. I think the kind of study about which Dr. Burr testified—Atomic Bomb Casualty Commission work—where we have a large population and a long history of seeing radiation exposures, and some better knowledge of what they have been doing over the last two decades for the purpose of the scientific investigation may be a better sample.

That does not mean we are disinterested in other cases where we can document the exposure and use it to supplement our knowledge.

Also, as a citizen I am concerned in another way. I am told by my medical friends that for example a barium enema provides an exposure of 5,000 Mrem. Thousands are given today in the United States. The physicians who order them apparently feel that the beneficial effect through the better diagnosis balances the possible damaging effects of that radiation exposure.

Mr. ROGERS. Well, that is true with X-rays, you balance risks and benefits. But this is not a balancing what we are talking about. There was no medical benefit to be received on all of these cases we are talking about, and I do not think we need to get off on a side issue here.

Mr. CARTER. Mr. Chairman, might I ask him this, how much exposure did you say a patient would get from a barium enema?

Dr. KERR. I am told on the order of 5,000 Mrem.

Mr. CARTER. 5,000 what?

Dr. KERR. Mrem.

Mr. CARTER. You are correct, that would be 5 rem.

Dr. KERR. That is correct.

Mr. CARTER. Thank you, Mr. Chairman.

Mr. ROGERS. And also, I must say, your concern on exposure does not go beyond 5 rem, below 5 rem per year.

Dr. KERR. I did not try to give you that impression, sir.

Mr. ROGERS. Well, you say you do not think a followup is necessary if these badges show they were not exposed.

Dr. KERR. I think in the operating sense—and let me try to distinguish between research and operations, just as Mr. Hollister tried to do—the person responsible for operations has guidelines and procedures that are based on those guidelines. That differs substantially, then, in terms of followup from the responsibility of a researcher who presumably should be interested in exposures down to near zero, or just above. An operating manager does not have research funds for followup, research people have to pick that project, justify it, and carry it forward. Clearly there are lessons to be learned from operating matters, Smoky being one, that should then perhaps motivate substantial research efforts. But different people will carry out research than carried out, for example, the test operations.

Mr. ROGERS. I understand that. I do not think that is an issue. What we are saying is, we need the research done, but no one conducting research is giving much attention to those not overexposed. That is what we are saying. We need to change that.

Mr. HOLLISTER. Mr. Chairman, could I comment on that a little bit?

Mr. ROGERS. Certainly.

Mr. HOLLISTER. As a person concerned generally with the operating radiation protection guidelines that the department uses, if I thought that our guidelines were set in such a way that every time a person went over he was in immediate need of medical followup, my conclusion would be that our guidelines are drastically wrong, that they should be lowered.

Guidelines, as testimony has been give to the Congress at different times over many years, guidelines are not a barrier between safety and danger; they are control points, if you will, and they are supposedly set low enough—not to insure absolute safety, no one argues that—but they are supposedly set low enough so that if we monitor occupational industrial personnel adequately, if we do the best we can to assure that they never go above; but if they occasionally do go above we are not automatically in some kind of medical situation.

Now, if there is an accident, if a laboratory experiment suddenly blows up, if someone suddenly gets unanticipated exposure then, certainly, that person is treated as a potential patient and is certainly examined, the history is looked at, and whatever treatment, or protection, or compensation he would be entitled to under law, he gets.

Mr. ROGERS. I understand, but the standard you set needs to be looked at, and the research done to see if it should be lowered. That is what I am saying.

Mr. HOLLISTER. Yes, sir.

Mr. ROGERS. Yet, you accept that as being a safety factor already geared into that standard. I doubt that is true.

Mr. HOLLISTER. I agree with you that the research you are speaking of needs to be done to the extent it can be done.

Mr. ROGERS. Well, it can be done. You have your population here to look at.

Mr. HOLLISTER. I am not sure that an epidemiologist, or a medical statistics specialist would agree with that.

Mr. ROGERS. Well, there are some that would. I am sure there may be some that would not.

Mr. HOLLISTER. They should decide, it should be decided by the scientific community.

Mr. ROGERS. Well, they have already decided to look at Smoky.

Mr. HOLLISTER. Yes, sir.

Mr. ROGERS. And I understand you have already agreed to look at all the others.

Mr. HOLLISTER. Yes, sir.

Mr. ROGERS. But now you are telling me it ought to be decided?

Mr. HOLLISTER. No, sir. I am simply posting a caution that the mere existence of records of overexposure does not necessarily promise that an adequate scientific study can be carried out. There are other factors—

Mr. ROGERS. That is exactly the point, you need to look at those underexposed. That is what I am saying, your policy generally has been only to be concerned with those overexposed, according to your viewpoint. Now, if you recall, some years ago the standard that they used was higher, and it changed when, in about 1956?

Mr. HOLLISTER. Yes, sir, about that.

Mr. ROGERS. So, all of a sudden the scientific community comes forth and says, "Oh, we were wrong before, now we will change." This really has not been looked at from an adequate scientific basis, even with all the experience we have here, for 20 years.

In fact, we are having scientists come to tell us now—and we had one Tuesday, Dr. Morgan—saying, "Of course, low-level radiation can cause great damage." And yet, it is still the official position, it appears, that, "Oh, no, it does not." I keep getting that from the Department of Defense and now the Department of Energy.

Mr. HOLLISTER. Well, it is certainly not the position of the Department of Energy.

Mr. ROGERS. Well, I would like to hear what is, then; what is the position of the Department of Energy on low-level radiation?

Mr. HOLLISTER. I believe I stated it just before the break, sir.

Mr. ROGERS. State it again, then because I did not understand it as a departmental position.

Mr. HOLLISTER. All right. I believe it is the department's position, recorded many times in testimony and elsewhere, that the only way to achieve zero risk from exposure to radiation is to have zero exposure.

Mr. ROGERS. All right, then how can you say that your medical experts can say that those three men who got leukemia, died of leukemia from Baneberry, did not get it from that?

I see your lawyer coming, and he would rather see you not comment.

Mr. HOLLISTER. I know what I want to answer, my only question was whether I would be able to say it. I may.

Let us suppose we are presented among our occupational workers—whether from Baneberry or other tests—production plants, or what not——

Mr. ROGERS. Let us just keep it to Baneberry.

Mr. HOLLISTER. All right. The mere fact that I am presented with cases of leukemia, and for those individuals I am also aware of their radiation exposure record which in this case for all three of them is one rem or less, the mere fact that I have that evidence does not make the case that the leukemia was caused by the exposure.

Now, it is quite true, and I would have perhaps phrased it a little bit different than Mr. Burr did, it is quite true that I cannot prove that it was not radiation-caused. You are dealing with a statistical situation.

Mr. ROGERS. That is right, and that is why we think it is necessary to do research on these troops to find out what low-level radiation does.

Mr. HOLLISTER. Well, I would agree with the proposition that the Government ought to do research wherever suitable—not by my definition, but by outside epidemiologists or whatever—wherever suitable human populations can be found for which exposure data are available.

Mr. ROGERS. And you do know, I am sure—and we are going to get into this on February 8—that when some of the scientists in this country, and in particular a scientist who was in charge of a study at Hanford, charges that his study which showed an adverse health effect from low-level radiation, you have tried to discount it. I do not mean you personally.

Mr. HOLLISTER. Yes, sir.

Mr. ROGERS. The Department of Energy and its predecessors have terminated his research contract because his findings were adverse. And there we reach the underlying theory, that the atomic energy industry and those who support it are not willing to admit the fact that low-level radiation is adversely affecting the health of people because that, then, would indicate a need for stricter standards.

Now, this committee has been trying to get to the bottom of this and find out what is going on. But we need some testing. It is a strange thing to me that the agencies which have the responsibility have not really been doing significant research on those people who have been exposed to low-level radiation. But we can go to Japan and do studies there.

So, this committee is very much concerned about this failure to conduct adequate research and we hope to get to the bottom of it. Dr. Carter? I am sorry to have taken so long.

Mr. CARTER. Thank you, Mr. Chairman. I would ask for equal time for the minority, if you please.

Mr. ROGERS. I will give it to you.

Mr. CARTER. Thank you. I will not try to take it. As they say at West Point, "Never bone when you can bugle." I am not trying to bugle, I will try to get to the point of the thing.

I am interested in one thing. I believe you said that the film badges of the 13 guards at the Baneberry explosion were recorded; is that correct?

Dr. KERR. That is correct, sir.

Mr. CARTER. The highest exposure was 0.98 rem and the others were less?

Dr. KERR. That is correct.

Mr. CARTER. And of 13 guards so exposed and later decontaminated, of that number 3 came down with leukemia and since have died; is that correct?

Dr. KERR. That is correct, sir. Excuse me, sir, let me correct that for the record, of the guards exposed only one had died.

Mr. CARTER. But of the 13, two others have leukemia.

Dr. KERR. No, not of that 13.

Mr. CARTER. Are you sure of that, now?

Dr. KERR. Yes, sir, I am.

Mr. CARTER. Only one of 13 guards, then, had leukemia. But what about the number that were decontaminated, I believe it was 84?

Dr. KERR. 86 were decontaminated.

Mr. CARTER. They were heavily irradiated, is that not correct?

Dr. KERR. I did not understand your question, sir, would you repeat it?

Mr. CARTER. As I understand it, 86 of the people at Baneberry were heavily contaminated, when this explosion vented. How many of those have leukemia and or have had leukemia and have died?

Dr. KERR. Of the 900 people evacuated 86 were found to have small amounts of radioactivity on them.

Mr. CARTER. All right, sir.

Dr. KERR. Of those 86, 1 died.

Mr. CARTER. How many have leukemia?

Dr. KERR. Sir, with the data I have available to me right now, the 3 you have referred to are among the population of 900. I cannot, with the information in my hand——

Mr. CARTER. That is not my information. My information is that the 3 were among the 13. That was my first information, and I think you are in error. I do not know that you are intentionally doing it, but you did not know and in fact had to question someone else before you could answer.

Dr. KERR. Mr. Amick advised me on that.

Mr. CARTER. But 3 out of 86 is above normal; is it not? Of course, you are trying to make the number exposed seem larger than what they are.

Dr. KERR. No, sir, I am not intentionally doing that.

Mr. CARTER. It is beyond my comprehension.

Dr. KERR. I am trying to be factual. I cannot testify that the 3 are among the 86.

Mr. CARTER. Will you describe the Hanford study, please, sir?

Dr. KERR. Dr. Burr can describe it.

Dr. BURR. The Hanford study of workers?

Mr. CARTER. Yes, sir.

Dr. BURR. That was a followup study, initially a retrospective study that was initiated first to see if it was feasible to go back in the records and make a roster of people that worked at Hanford, and to establish what they did.

Mr. CARTER. I do not want the procedure, I want the results. What was the percentage of excess cancer deaths found by Mancuso among the workers at Hanford?

Dr. BURR. I will ask Dr. Weyzen to respond to that.

Mr. CARTER. You mean that you do not know?

Dr. WEYZEN. I am Dr. Walter Weyzen.

In the report, the final report of the study, there was a claimed increase in the incidence of leukemia, breast cancer, cancer of the pancreas. That report has been since reviewed.

Mr. CARTER. No; I did not ask you that. What I want to know is the percentage of the excess cancer mortality found among Hanford workers studied by Mancuso. Could you give me the percentage please, sir?

Dr. WEYZEN. The way the data were expressed I do not think I could extract the percentage, sir.

Mr. CARTER. My data show it is a 7- to 10-percent increase. What happened to Mancuso?

Dr. KERR. Sir, if I might interrupt. Is it my understanding that this committee is having a hearing on the Mancuso incident——

Mr. CARTER. Yes, sir.

Dr. KERR. We came prepared to discuss the questions that the committee gave us with respect to testing, not Mancuso——

Mr. WALGREN [presiding]. If I might interrupt here. It is my understanding that the members of this committee have a right to ask any question that they feel is proper; and the witnesses have an obligation to respond to that question if they have any knowledge in that area. If you have no knowledge in that area, you may say so.

I would also like to caution the witnesses that when a member is posing a question, it is very difficult for the stenographer to take down two people talking at once. Members of this committee will do everything they can to let you express yourself fully. I would like to caution you from talking at the same time that a member is trying to pose a question.

One other point, since we are questioning a person who came in from the side. Would you please identify yourself, since these questions are directed to you, so the record will clearly state who is answering the question at this point?

Dr. BURR. I turned to Dr. Weyzen, and I am Dr. Burr. Dr. Weyzen is the manager for our human health studies in the Division of Biomedical and Environmental Research of the Department of Energy.

Mr. WALGREN. Would you like to restate your last question regarding the percentage in Dr. Mancuso's study?

Mr. CARTER. Yes. I would like to know the percentage of the excess cancer deaths in the people who worked at Hanford.

Dr. WEYZEN. I do not have the percentage on it, but I can provide it for the record.

Mr. CARTER. Well, sir, I have a little difficulty myself but I am pretty sure that I read 7 to 10 percent.

You spoke, Doctor, of checking radioactivity through scanning, in addition to the film badges. What method of scanning did you use?

Dr. BURR. I believe, Dr. Carter, I did not mention scanning per se, although that is widely used in nuclear medicine as a method of localizing radioactivity in the body.

What I believe I mentioned was whole-body counting, which is an effort——

Mr. CARTER. How does this differ from scanning?

Dr. BURR. Well, it does not necessarily imply that the detector moves over the body. The individual may be in a chair position approximately a meter from a detector, and then the detector looks at the entire body. That is one of the ways it can be done.

Mr. CARTER. Yes, sir.

Dr. BURR. It can be done by moving the detector, or the individual, too.

Mr. CARTER. Were you present at any of these explosions?

Dr. BURR. At the test?

Mr. CARTER. Yes.

Dr. BURR. No, sir, not at any of the tests in which military troops were involved.

Mr. CARTER. What about any atomic test?

Dr. BURR. I have been present at one underground shot in more recent years.

Mr. CARTER. It did not vent, I take it.

Dr. BURR. No, sir; it did not.

Mr. CARTER. How many of you other gentlemen were present at any tests with the AEC?

I notice you are wearing dark glasses; by any chance, have you had a cataractectomy?

Mr. JACKS. No, sir; I just do not like the bright lights.

Mr. CARTER. I see most of you gentlemen wear dark glasses, or heavy glasses. How many of you have had cataracts removed, any of you?

In Japan, there was a study made by J. Rotblatt of "early entrants" into Hiroshima. Can any of you give us what he found there? Are you familiar with Rotblatt's study?

Dr. **Burr.** I am not familiar with studies of Rotblatt in Japan. He is a British investigator, but I do no know of his Japanese study. I am sorry. I believe he interpreted Japanese studies.

Mr. **Carter.** It is my understanding that his study found an increased risk for leukemia among those who went into Hiroshima after the bombing for rescue work or in search of relatives. There were 40,000 who went in, and the leukemia risk factor was increased 9 percent, plus or minus 4 percent, in those who went in after the blast. Would you care to comment?

Dr. **Burr.** I am not sure that I followed those statistics. Knowing the number of cases, as I am sure you are aware, does not help you unless you know how many people are involved. I really cannot comment on these data.

Mr. **Carter.** There were 40,000 people who went into the area after the bomb was dropped, and there was an increase in the leukemia risk factor of 9 percent, plus or minus 4. So, there is the possibility of a great increase of this cancer.

Now, if we could go back to Smoky. In that case, actually, there are 447 persons who have been located and, of that number 8 have come up with leukemia. Do you feel that this is statistically significant?

Dr. **Burr.** Again, Dr. Carter, the problem is knowing, as was said yesterday, what the denominator really is. In other words, that is eight cases out of really how many people.

You have to know whether or not you really have whole sample when you make an interpretation as to whether it is significant or not. I think the way it was covered by Dr. Caldwell and his chief was quite appropriate.

Mr. **Carter.** I believe that they said it was statistically significant.

Dr. **Burr.** However, I think they cautioned that until you really know the age of the individuals that were actually involved, it is hard to make a firm prediction of what you would expect.

Mr. **Carter.** Yes, sir. Well, we believe that the average age of the majority of them would not be from 40 to 44 and the usual incidence of this disease among this age group is 4.1 per 100,000. In this case it was 8 out the 447 who have been located. The incidence could be much, much higher and we think that it will prove to be.

By the way, what is the level at which radiation can cause cancer? Is there any such level?

Dr. **Burr.** Well, cancer is among the late somatic effects of radiation.

Mr. **Carter.** One of the late effects.

Dr. **Burr.** Under present concepts, as I said in the beginning, I think it is prudent to accept that there is some risk with any amount of radiation. Consequently one would have to say there is some increased risk. I do not think you can draw a level, Dr. Carter, and say there is no risk below this with out present knowledge. Now, three may be that because there are other things that affect the dose response, there is dose rate and other factors. But I do not think at this time you can do this. You probably have slight increase in probability that is associated with exposure.

Mr. **Carter.** What was the first record of a burn from X-rays?

Dr. **Burr**. I do know that I can give you the first record, but it occurred very quickly after Roentgen's discovery in 1895 of X-ray. This was reported rather quickly thereafter.

Mr. **Carter**. The first radiation burn was not from that, of course, but occured with an associate of Madame Curie.

Dr. **Burr**. That is right, Dr. Beckerell, I believe. That was in the discovery of natural radioactivity—excuse me.

Mr. **Carter**. And, as I remember, Curie then himself took a piece of radium and burned himself; is that not correct?

Dr. **Burr**. I am sorry, I do not necessarily remember that, sir.

Mr. **Carter**. All right.

On the Marshallese, now, my friends, you are familiar with these tests there?

Dr. **Burr**. I am familiar with the medical followup more than the tests themselves.

Mr. **Carter**. All right. What did the medical followup show, was there an increased incidence of cancer, tumors?

Dr. **Burr**. The medical group at Brockhaven National Laboratory which followed this population for the Department of Energy and previously for the AEC—the medical group at the Brookhaven National Laboratory, saw an increase in thyroid abnormalities, thyroid tumors. Most of these were benign lesions, but there was an increase.

Mr. **Carter**. There were thyroid malignancies, were there not?

Dr. **Burr**. Yes, sir.

Mr. **Carter**. Did the Marshallese lose their hair and teeth?

Dr. **Burr**. There were also some initial effects, there were burns, and some of the individuals, I believe, lost hair.

Mr. **Carter**. And, in this case, you do admit that atomic radiation does adversely affect humans?

Dr. **Burr**. Yes, sir, at the levels of exposure that they received there were adverse effects.

Mr. **Carter**. Do you know the death rate among those people?

Dr. **Burr**. I do not know what the death rate is.

Mr. **Carter**. How many have died as result of the explosions?

Dr. **Burr**. There was one individual who developed leukemia and he subsequently died.

Mr. **Carter**. One case of leukemia there. Did you, or did the Atomic Energy Commission recommend that these people be compensated? Where did that legislation originate?

Dr. **Burr**. I am not an authority on where legislation originated—excuse me, sir.

Mr. **Carter**. Surely one of you at the table knows, you have your attorney here.

Dr. **Burr**. I would say that we recommended they be compensated.

Mr. **Carter**. You did recommend that?

Dr. **Burr**. Certainly.

Mr. **Carter**. Then legislation was recommended by your agency and passed by Congress, and we are compensating these Marshallese people.

Now, why are you denying the same support for our GI's who suffered radiation effects at Smoky and at other areas? Are you contending that they should not be compensated when it was testified to yesterday by independent people that the incidence of leukemia and other cancers (with other cancers expected to be 1½ times as common as leukemia) has increased among those at Smoky?

Dr. **Kerr.** We are not denying that they should be compensated, sir. But because they were military personnel on active duty at the time, their procedure for making claims against the Government is not through the Department of Energy, but rather through the Department of Defense.

Mr. **Carter.** Yes, sir. Well, do you accept that radiation from atomic blasts caused leukemia in those cases?

Dr. **Kerr.** No, sir, I cannot testify to that effect. First because I am not an expert on health effects of radiation——

Mr. **Carter.** You have some physicians here.

Dr. **Kerr** [continuing]. And second because I do not think in a statistically significant scientific sense it has been established without question.

Mr. **Carter.** Well, I cannot agree. I would like one of the physicians to answer that.

Dr. **Burr.** Well, I think that Mr. Hollister stated that rather clearly, and I really do not differ with his opinion. There are many reasons, most of which we really do not understand—some we do—why people develop leukemia. They certainly do not all develop leukemia from radiation. And to show a causative effect——

Mr. **Carter.** We do not just say leukemia. In fact, for every case of leukemia, you can expect 1½ cases of other cancer. So it is not just leukemia, but other forms of cancer. Skin cancer is probably the most common one.

Mr. **Hollister.** Mr. Chairman, could I make a comment?

Mr. **Carter.** Certainly.

Mr. **Hollister.** I think two things need to be separated. One has to do with the Government as a compassionate agent, and the other has to do with research and scientific findings. Without getting into the legalities of any particular contention, the Baneberry case, or anything of that sort, I believe that it is the Government's position—certainly the Department's position—that there are cases of cancer or whatever that might be presumptively—presumptively—associated with a person's occupation under our jurisdiction, and that person should receive care, compensation, or whatever, without going into the scientific question of whether proof of illness from radiation can be established. I think if we could separate the scientific issue, which is not always clear, and the compensation, the humane compensation issue, I think it would help the discussion somewhat. That is just a suggestion.

Mr. **Carter.** Well, your agency did recommend that the Marshallese be compensated.

Mr. **Hollister.** Yes, sir. May I comment——

Mr. **Carter.** I want to say further on that, always you say that we do not have statistically significant information. Now, that is simply not correct; 8 people out of 447 at Smoky have or have died of leukemia. Yet, you want to relate that to a base of thousands instead of the 447 persons who have been located. It is statistically significant. There is no question about it, as I see it. Personally I feel that those people should be compensated.

By the way, Doctor, what are the symptoms of radiation sickness?

Dr. BURR. Well, that is, of course, dependent upon dose.

Mr. CARTER. Of course. If you have 300 rem say, what happens then?

Dr. BURR. Well, one would anticipate that you would see nausea rather promptly; you would see subsequently a fall in some formed elements of the blood. You would see vomiting, probably, at that level.

Mr. CARTER. You would see what?

Dr. BURR. You would expect to see vomiting.

Mr. CARTER. At 300 rem?

Dr. BURR. Yes, sir. That is an acute exposure.

Mr. CARTER. What about death?

Dr. BURR. It would be less than what we consider the LD_{50} to be; it would depend of course on the medical management.

Mr. CARTER. I believe that is about the limit for radiation. You can go either way; you might recover, or you might die from it. Above that the chances are that you would be killed, at 600 rem anyway.

Now, let us go back to the symptoms of radiation sickness.

Dr. BURR. Well, first of all, Doctor, remember, while I am a physician, I am in research primarily, but I will go ahead and talk to you about symptoms.

Mr. CARTER. You know much more, of course, when you are in research.

Dr. BURR. We mentioned the nausea, the vomiting. Subsequently there will be a fall in the——

Mr. CARTER. How about nosebleed?

Dr. BURR. You might see it.

Mr. CARTER. No; that is one of the most common symptoms of exposure.

Dr. BURR. But not early. When the platelets have fallen, when the platelets have been depressed enough you may see this.

Mr. CARTER. Yes, you would expect platelet depression. But it comes rather early after exposure. And some of these people who were at Smoky had these symptoms after their exposure. Of course, there were several exposures, not just one. I do not mean to refer just to the Smoky blast, of course, as there were several blasts and participants showed these symptoms at that time.

You are familiar with the Mancuso study, Doctor?

Dr. BURR. Yes, sir, I am familiar with the Mancuso study.

Mr. CARTER. Well, tell us about it, if you are familiar with it.

Dr. BURR. Well, I will go back to the establishment of the study. It was, as I said, a retrospective study; a followup study on workers at Hanford and at Oak Ridge. The study was initiated with a contractor, who was Dr. Mancuso, who first established that it would be possible to do such a study, and then commenced the study. It has subsequently been reassigned and will be continued at Oak Ridge, at the Oak Ridge-Associated Universities; and also some of the studies will be continued at Hanford.

Mr. CARTER. Was there a Dr. Sam Milham in charge of this study first?

Dr. **Burr**. No, sir. Dr. Milham was a member of the Department of Health, I believe, of the State of Washington. He was not associated with this study.

Mr. **Carter**. Mancuso's study did show an increase in cancer deaths among workers at the Hanford facility; is that not true?

Dr. **Burr**. Dr. Weyzen is more familiar with this final report, and I will ask him to comment.

Mr. **Carter**. I will take the one who is more familiar.

Dr. **Weyzen**. The final report of the study that was published in September or October of 1977 indicates an increase in various types of cancers.

Mr. **Carter**. It does show an increase then? How much of an increase?

Dr. **Weyzen**. I do not know the percentages right now, sir.

Mr. **Carter**. Yes, sir. What happened to the Mancuso study?

Dr. **Weyzen**. The contract with the University of Pittsburgh was terminated on July 31, 1977.

Mr. **Carter**. Did he receive a letter before he had thought about retirement, stating that he would have his contract ended because he was expected to retire?

Dr. **Weyzen**. Dr. Mancuso was informed at a meeting in March 1975, and subsequently in a letter of January 1976, that his contract would be terminated; yes.

Mr. **Carter**. Thank you, Mr. Chairman.

Mr. **Rogers**. Mr. Walgren?

Mr. **Walgren**. Just a couple of thoughts. Mr. Kerr, you are a medicial doctor, or what kind of a doctor?

Dr. **Kerr**. No, I am a physicist.

Mr. **Walgren**. A physicist. What has been your maximum exposure, personally, in a year in terms of rem on the 5-rem scale?

Dr. **Kerr**. I think the maximum exposure in my personal radiation history is about 2. But a fair part of that was due to the fact that I lived in Los Alamos, N. Mex., at the time in an altitude of 7,000 feet, and received on the order of 30 millirem a month from the natural background.

Mr. **Walgren**. How about the other gentlemen, could we go with maximum exposure per year in rem?

Mr. **Hollister**. Would you like me to go next?

Mr. **Walgren**. Yes.

Mr. **Hollister**. If you are asking about my maximum exposure from all sources, I do not have the slightest idea because I never ask my dentist what I get in a mouth X-ray; I never ask my physician to tell me when he gives me a chest X-ray, I rely on his judgment.

If you are asking what I have received occupationally, and I have worked at Hanford and at Livermore, I have not the slightest idea there either, but it was not because I was not told.

Mr. **Walgren**. Why was it?

Mr. **Hollister**. It was so small that I probably threw the pieces of paper in the wastebasket.

Mr. **Walgren**. And have you ever been at any incident that had an exposure of some magnitude worth recording on a badge?

Mr. **Hollister**. That has been called to my attention, you mean?

Mr. **Walgren**. Yes.

Mr. **Hollister.** To my knowledge and recollection, no, sir.

Mr. **Walgren.** Going down the line, then.

Dr. **Weyzen.** My whole-body exposure is about 4½.

Mr. **Walgren.** How did that happen?

Dr. **Weyzen.** Laboratory exposures.

Mr. **Walgren.** And would that be within 1 year?

Dr. **Weyzen.** No, that is over the period of 10 to 12 years.

Mr. **Walgren.** And you have never been at an incident worth recording by a badge?

Dr. **Weyzen.** Pardon me?

Mr. **Walgren.** You have never been at an incident worth recording by a badge mechanism?

Dr. **Weyzen.** Film badges are worn routinely by everybody that has a potential for exposure to radiation.

Mr. **Walgren.** Yes?

Mr. **Hollister.** Was that your question to me?

Mr. **Walgren.** Yes.

Mr. **Hollister.** I thought your question was, did the film badge reading ever get called to my attention because someone was concerned.

Mr. **Walgren.** I am interested in what your personal exposure has been. Here we are concerned about people receiving 5 rem a year and we are wondering whether or not lower radiation levels are possibly dangerous. Now I am interested in what your personal exposures have been within 1 year's time, having worked in the occupation that you have.

Dr. **Kerr.** Might I interject a comment?

Mr. **Walgren.** Yes.

Dr. **Kerr.** There are at least two gentlemen with me here who have had substantially larger exposures as participants in test operations. If you would like to hear from them, in order to get the other end of the scale, we could ask them to testify.

Mr. **Walgren.** That would be interesting. Let us go down the line.

Dr. **Burr.** I could not give you the answer in my case either because I have never had a film badge reading in an amount to give me concern. I probably have had more exposures around medical procedures than I have had in the lab.

Mr. **Walgren.** I see. Generally, then, your experience is some exposure to radioactivity and a feeling that the level of the exposure to which you have personally been exposed is of no great concern to you.

Dr. **Burr.** Yes.

Mr. **Walgren.** I guess I should address these questions to Dr. Kerr. Considering the Marshall Islands experience, are you familiar with the research that has been done on the population of those involved in the exposure in the Marshall Islands?

Dr. **Kerr.** No, I am not personally technically familiar with it, but there are people here who have closer association with those followup studies.

Mr. **Walgren.** Which one would that be?

Dr. **Kerr.** Dr. Burr.

Dr. **Burr.** When I mentioned Rongelap and Utirik, those are the followup studies that we are talking about in the Marshall Islands.

Mr. **Walgren**. Now, Utirik is one island, is that correct?

Dr. **Burr**. That is right.

Mr. **Walgren**. And the other name is another island?

Dr. **Burr**. Rongelap is another island.

Mr. **Walgren**. What was the maximum exposure on Rongelap?

Dr. **Burr**. I think it was approximately 175 rem.

Mr. **Walgren**. And what was the maximum exposure on Utirik Island?

Dr. **Burr**. That was much lower, approximately 15. I think it was actually 14.

Mr. **Walgren**. Fourteen rem. Now, what have been the findings in terms of unusual illnesses, particularly cancer, in relationship to the population on both islands?

Dr. **Burr**. As I mentioned previously, the findings have been principally increases in thyroid abnormalities, and these have ranged from hypothyroidism to tumors, benign adenomas, or cancers.

Mr. **Walgren**. How about incidence, numbers of occurrences? Let us take the high-exposure island first. Do we know how many unusual occurrences we found on the high-exposure island?

Dr. **Burr**. Just one second, I am looking at a table which does give you that information.

I think the number I am looking at breaks this out in terms of thyroid cancer, which shows in this particular table an incidence of 7 thyroid cancers, in the exposed population of 243. There have been more thyroid lesions than that.

Mr. **Walgren**. That is 7 out of 243?

Dr. **Burr**. Yes.

Mr. **Walgren**. And how about on the low-exposed island, Utirik, which received 14 rem?

Dr. **Burr**. Dr. Weyzen tells me there have been three on Utirik.

Mr. **Walgren**. Out of how many?

Dr. **Burr**. If I can introduce one more individual, Dr. Victor Bond, who is a physician and is the associate director of Brookhaven National Laboratory. He has been familiar with this popuation since they were exposed. He was on several of the early medical visits. He has had the responsibility for the medical followup. I think he can give you better statistics than I can.

Mr. **Walgren**. Thank you. If you would, Doctor, just sketch out briefly the comparisons between incidences on the high-exposure island the low-exposure island.

Dr. **Bond**. Yes, sir. The total numbers first on Rongelap, total number exposed was 64; and the doses to the thyroid gland, which I believe is pertinent here, were 335 to 1,150 rad; that was the range.

In Utirik the total number of those exposed was 158, the dose range for the thyroid was 30 to 95.

The latest figures with respect to abnormalities are the following: In terms of actual numbers in Rongelap there have been four thyroid malignancies; in Utirik there have been three. Malignancies of the thyroid are usually accompanied by nonmalignant thyroid nodules. In this case there have been zero nodules in the Utirik population, but a total of 19 in the Rongelap population.

Mr. **Walgren**. Now, focusing on the cancers themselves, would you characterize the comparison between the high-exposure island

and low-exposure island? You would expect to see less cancers on the low-exposed island than you have actually found?

Dr. **Bond**. That is correct, sir, you would expect to see fewer than we actually saw.

Mr. **Rogers**. Excuse me, I could not hear the answer.

Dr. **Bond**. I am sorry, sir. One would expect to see fewer, and the numbers that we have at the present time are more.

Mr. **Walgren**. And so, the incidence of cancer in the low-exposed population is in this instance surprisingly high.

Dr. **Bond**. Surprisingly high, yes, sir.

Mr. **Walgren**. I wanted to go back to perhaps get a direct refusal from Dr. Kerr to give us his own opinion on whether or not the exposures caused the leukemia that Dr. Carter asked. I do so because it was apparently department policy that you were unwilling to give us your personal opinion on that; is that correct?

Dr. **Kerr**. No; I would very much like to correct the record on that point. As I mentioned to you just now, I am a physicist, not a medical doctor. I understand as a lay person with respect to the question, that there is a connection between radiation at some level and leukemia. But I am not personally knowledgeable in order to respond to the question that Dr. Carter asked.

Mr. **Walgren**. You have no opinion one way or the other?

Dr. **Kerr**. What I said was that I believe radiation and leukemia are linked at some level of radiation exposure. What I am saying is, that I cannot from my personal knowledge testify as to whether the cases he mentioned were caused by the radiation exposures measured.

Mr. **Walgren**. Well, from a layman's standpoint I really believe that what we have in this record is a developing evidence of low-level radiation being possibly a very serious hazard to health. The people that have been involved in investigating up to this point have either institutionally, or personally certainly not been suspicious; and we have yet to find one that would state that he really believes that this low level radiation warrants tremendous investigation. We have the Department of Defense allocating one person one-quarter time.

I personally would feel much more comfortable if, Dr. Kerr, we had somebody in the capacity of supervising this kind of investigation who really would go further than saying they have no opinion, but were skeptical enough to really suspect that something adverse may be happening here. I do not see that in the panel that the Department of Energy is presenting to the public, and I think the public deserves more than that.

Dr. **Kerr**. May I respond to that?

Mr. **Walgren**. Yes.

Dr. **Kerr**. I think I tried at the outset to make clear that I was speaking to you from the point of view of the defense program part of the Department. My associates here have told in some detail of some of the health research they sponsor in their part of the Department.

Your inferring from my words that I am uninterested in the possible connections between low-level radiation and the human health, that is not the case at all. I, like you, share a concern for that. I have been exposed to low-level radiation, as many people have; some of my associates here have been exposed rather more. It is clearly a concern of the Department. They are carrying out some projects in this area now. Whether our response is sufficient to our new perception of the need, as perhaps demonstrated by the CDC studies, is a question which you debate and decide. But we are responding. We have done some things both in the health effects area, and by increasing our activity and making accessible radiation exposure data from the past, to move things along. It is an acceleration. Whether it is fast enough, or not, you and the public will judge.

Mr. WALGREN. Well, let me just go to the depth of that response. The testimony yesterday was that if the CDC gave the Department of Defense names, they would then provide records on those names. But they were not prepared to be able to provide the CDC any comprehensive list of people that had been exposed, from their own records.

Now you testify today that an incomplete review of available records revealed about 900 test participants that exceeded the permissible exposure amounts for whole-body penetrating radiation.

Now, I would, I guess, like to know from the public's point of view, what would it take to make a complete review of available records; is that beyond the Department's capability?

Dr. KERR. We are, in the Department of Energy, reviewing our records, and stand ready to make all the records we have available to CDC, which has as yet not requested them.

Mr. WALGREN. You have names and exposure records for 900, I take it, that you referred to on page 12 of your testimony.

Dr. KERR. The answer is yes to the 900. But beyond that, I testified earlier, that we have 347,640 records from continental U.S. tests, and 110,650 for Pacific test operations.

Mr. WALGREN. Not to belabor the point, how did you find 900 out of the 300,000 plus 164,000?

Dr. KERR. I am told simply by reviewing the reports available now in our files.

Mr. WALGREN. Have all the files been reviewed?

Dr. KERR. No, sir, they have not all been reviewed.

Mr. WALGREN. Can you tell us how much review work needs to be done to make that a complete check?

Well, let me ask you this, you have 900, how many of the 450,000 people's files were reviewed to pull out the 900 where we see the exposures exceeding permissible amounts? What percentage of the files have we reviewed to get 900?

Dr. KERR. I am told 85 or 90 percent. The gentleman who is providing me some assistance in this is Bruce Church, he is chief of the Radiological Safety Branch in the Nevada Operations Office. It is being done under his cognizance and with the assistance of the contractor REECO. He stated that he thinks about 85 percent of the records have been reviewed. That the completion of that review would take something on the order of a few weeks to a couple of months. We are not working on it with a fraction of one man, I might add.

Mr. WALGREN. Can you give me an estimate on how much effort has gone into reviewing 85 percent of the files?

Mr. CHURCH. In terms of man-years, that kind of effort?

Mr. **Walgren**. Yes.

Mr. **Church**. We probably had this past year 2 to 4 man-years committed to that kind of effort. My group has been involved for the last 7 years trying to organize and find historical records and put them in some kind of order so that they might be used for recalling and reviewing. That work has been going on for about 7 years, or longer. The fact is, some fragments of that work go back to the 1960's.

Mr. **Walgren**. But in the last year four men on the outside work on this over the year.

Mr. **Church**. Approximately four.

Mr. **Walgren**. Approximately four men over the year. Well, I can only say if you are saying on the outside you will be able to review all those files within no more than 2 months, that information will be available to make some good conclusions.

Thank you, Mr. Chairman.

Mr. **Rogers**. Would you report to the committee when that is completed, when you anticipate it and the results?

Dr. **Kerr**. Yes, sir; we will be pleased to do that.

Mr. **Carter**. Mr. Chairman?

Mr. **Rogers**. Dr. Carter?

Mr. **Carter**. How many of the Marshallese were exposed, Doctor?

Dr. **Bond**. I am sorry, sir, I did not hear the question.

Mr. **Carter**. How many of the Marshallese were exposed in 1954?

Dr. **Bond**. The total number on Rongelap is 64; the total on Utirik is 158.

Mr. **Carter**. That's 64 plus 158. How many have cancer of one form or another, thyroid or otherwise?

Dr. **Bond**. On Rongelap the numbers with thyroid cancer, the total is four; on Utirik the total number is three. Of other cancers that have been associated with radiation exposure, there has been one leukemia on Rongelap.

Mr. **Carter**. So, the total number of cancers out of 222 is what?

Dr. **Bond**. The total is seven of the thyroid and one leukemia, that is eight.

Mr. **Carter**. Eight. That would be an incidence of roughly 4 percent.

Dr. **Bond**. Of that order.

Mr. **Carter**. Yes, sir. Thank you very kindly, Mr. Chairman.

Mr. **Rogers**. Let me just conclude by asking you to furnish for the record, if you would, please, some information; and we may also submit some questions that we would like answered for the record, too.

Would you provide for the record, a description of each of your low-level radiation health effect studies of the last 10 years; the principal researcher, and his affiliation, institutional, departmental, or agency?

The names of all those working on each particular contract or project.

[See topic A-7 DOE responses on p. 448.]

Mr. **Rogers**. We would also like to know of any history of previous employment with AEC, ERDA, or DOE, and the dollar amount by year of each research contract.

Also, we would like to have DOE conduct and provide for the subcommittee a complete current review of the medical history of the 900 involved in Baneberry, and maybe you could just answer this last question for me right now: Is it true that anyone with security clearance—for instance secret clearance or classified clearance even though they may have that—cannot get any particular information on these records unless they have a contract with DOE or DOD?

Dr. **Kerr**. No, sir, that is not true. Specifically, sir, the exposure records, there is no problem with access there. The only access that is protected on some of the past tests is the actual design of the device and some of the data on how it worked.

Mr. **Rogers**. What about fallout levels, is that classified; would that be available?

Dr. **Kerr**. I think, sir, with respect to radiation exposure the fallout can be made available as well, there is no problem with classification.

Mr. **Rogers**. Thank you very much.

We may have further hearings on the matter, but we are grateful to your for being here, for helping the committee. We appreciate your presence. If you could get for the committee the information we asked for as soon as possible, we would be grateful.

Dr. **Kerr**. We will do that, sir, and thank you very much.

[Testimony resumes on p. 461.]

[The following questions and answers were submitted for the record:]

DOE RESPONSES TO QUESTIONS FROM SUBCOMMITTEE ON HEALTH AND THE ENVIRONMENT

Question*	Status
A-1.	The complete list of 606 announced tests was provided to the Committee on January 26, 1978 and is in subcommittee file
A-2.	Response provided February 14
A-3.	Response provided February 8
A-4.	Partial answer to be provided at February 14, 1978, hearing, further information by March 29
A-5.	Response provided February 14
A-6.	Exposure record totals provided to Committee on January 26, 1978, further response February 8
A-7.	Partial response February 8, completed February 14
A-8.	Response provided February 8
A-9.	Information will be provided by March 29, 1978
A-10.	Response provided February 8

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*Questions A-1. through A-10. were derived from the January 26, 1978, hearing transcript; questions B-1. through B-15. were provided in writing by the Committee's staff. The full set of questions was an attachment to the February 8, 1978, letter to the Committee.

Topic A-2

Q: List the radiation guidelines which were applicable to each test series.

A: The attached table summarizes the whole-body penetrating radiation guidelines. Those guidelines shown for the Pacific Test series were applicable throughout the Joint Task Force. Guidelines for onsite at the Nevada Test Site were applicable to all personnel who were under the cognizance of the AEC's NTS Test Manager. (DOD Desert Rock Exercise participants were not under the AEC's cognizance after 1952.) Exceptions to the guidelines were authorized under special operating circumstances such as for personnel flying cloud sampling missions.

Also attached is a tabulation of the various radiation standards and guides which were provided by the national and international bodies that have furnished the accepted guidance on these matters. The exposure criteria used during test operations were derived from these standards and guides. It should be noted the 3.0 R per 13 weeks adopted in 1954 by the NCRP and in 1958 by the ICRP was a guide consistent with testing operations since the testing series conducted during these years each extended over 4 or 5 months so that 3.9 R for the operation was comparable to or lower than the 3.0 R per 13 weeks.

EXPOSURE CRITERIA

(ALL CRITERIA ARE WHOLE-BODY RADIATION EXCEPT WHERE OTHERWISE INDICATED)

CY	SERIES	ONSITE#	OFFSITE
'46	CROSSROAD*	-	-
'48	SANDSTONE*	0.1 R/24 hr 3.0 R/30 days with authorization	not specified
'51	RANGER	3.0 R for series } 5R total for joint participants	not specified
	GREENHOUSE*	5.0 R for series	not specified
	BUSTER/JANGLE	3.9 R/13 weeks	3 R/10 weeks
'52	TUMBLER/SNAPPER	3.0 R for series	not specified
	IVY*	3.0 R/3 months	not specified
'53	UPSHOT/KNOTHOLE	3.9 R/13 weeks	not specified
'54	CASTLE	3.9 R/Operation .3 R/week for 13 consecutive wks. up to 7.8 R/Operation JTF-7	not specified
'55	TEAPOT	3.9 R/Operation	3.9 R/year
	WIGWAM*	3.9 R/Program 20 R/Program (hands & feet) 10 REP beta 20 REP beta (hands & Feet)	not specified
'56	REDWING*	7.0 R WB/Operation	not specified
'57	PLUMBBOB	3.0 R-13 consecutive weeks 5.0 R/year	3.9 R from Operation
'58	HARDTACK I*	3.75 R-13 consecutive weeks 5.0 R-for Operation 5.0 R/yr.	not specified
	ARGUS	-	-
	HARDTACK II	3.0 Rem/qtr. 5.0 Rem/yr.	3.9 Rem from Operation
'61	NOUGAT	3.0 Rem/qtr. 5.0 Rem/yr.	3.9 Rem for year
'62	DOMINIC	3.0 Rem/qtr. 5.0 Rem/yr.	not specified
'62	STORAX	3.0 Rem/qtr. 5.0 Rem/yr.	3.9 Rem for year

CY	SERIES	ONSITE#	OFFSITE
'62	DOMINIC II	3.0 Rem/qtr. 5.0 Rem/yr.	3.9 Rem for year 10.0 Rem/10 years
'63	NIBLICK	" "	" "
'64	WHETSTONE	" "	" "
'65	FLINTLOCK	" "	" "
'66	LATCHKEY	" "	" "
'67	CROSSTIE	" "	" "
'68	BOWLINE	" "	" "
'69	MANDREL	" "	" "
'70	EMERY	" "	" "
'71	GROMMET	" "	" "
'72	TOGGLE	" "	" "
'73	ARBOR	" "	" "
'74	BEDROCK	3.0 Rem/qtr. 5.0 Rem/yr.	3.9 Rem/yr. 10 Rem/10 years 170 mRem/yr. general population
'75	ANVIL	" "	" "
'76	FULCRUM	3.0 Rem WB qtr.** 5.0 Rem WB/yr.** 5(N-18) WB* 10 Rem/cal. qtr.*] skin, thyroid, 30 Rem/yr.*] bone 25 Rem/cal. qtr.*] 75 Rem/yr.*] hands, forearms, feet, ankles 5 Rem/cal. qtr.*] 15 Rem/yr.*] other organs Internal exposure limits per Appendix ERDAM 0524 1977	170 mR WB/yr. 500 mR avg. Thyroid/yr. If remedial action can be taken 0.5R WB/yr. 1.5R Thyroid/yr.
'77	CRESSETT	3.0 Rem/qtr. 5.0 Rem/yr.	170 mRem avg. WB/yr. lge. pop. 500 mRem WB/yr. (individual) 500 mRem agv. Thyroid/yr.

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* Pacific Test Series

** Except as authorized by Manager

#On certain atmospheric test operations exposures above the listed onsite exposure criteria were authorized.

NOTE:
r=R
rem=Rem

CHRONOLOGY OF RADIATION STANDARDS FOR OCCUPATIONAL EXTERNAL WHOLE-BODY DOSE EQUIVALENT LIMITS, 1947-1978

YEAR	NCRP NATIONAL COUNCIL ON RADIATION PROTECTION AND MEASUREMENTS		ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION		FRC(1960) FEDERAL RADIATION COUNCIL	
	CRITERIA	REFERENCE	CRITERIA	REFERENCE	CRITERIA	REFERENCE
1947 ↓	0.1 R/day 0.5 R/wk	NBS Handbook #18	0.2 R/day 1.0 R/wk ↓	-- --	-- --	-- --
1949	0.3 R/wk ↓	NBS Handbook #42	↓			
1950	↓		0.3 R/wk ↓			
1951	↓		↓			
1952	↓		↓			
1954	3.0 R/13 wks 0.3 R/wk(max) 15 Rem/y	NBS Handbook #59	↓			
1957	5 Rem/y average 12 Rem/y max	ADDENDUM NBS Handbook #59	↓			
1958	0.3 rem/wk (max) 3 rem/13 wks 12 rem/y max 5(N-18) rem	ADDENDUM NBS Handbook #59	0.1 rem/wk 3.0 rem/13 wks 5(N-18) rem	ICRP Report #1		
1959	↓		↓			
1960	↓		↓		3 rem/13 wks 5 rem/y average 12 rem/y max 5(N-18) rem	FRC Report #1
1965	↓		3 rem/13 wks 5 rem/y (max)	ICRP Report #9	↓	
1971	3 rem/13 wks 5 rem/y	NCRP Report #39	↓		↓	
1974	↓		↓		↓	
1978	↓		↓		↓	

Topic A-3

Q Explain the situation with regard to personnel exposure records as regards their completeness, the matter of DOD exposure information in the REECo file.

A A list of the number of personnel exposure records maintained by REECo for DOE/NV was given to the Committee by Dr. Kerr during his testimony which included qualifications regarding these records. Expanded qualifications and explanations regarding these records are as follows:

a. Prior to the 1956 Redwing operation, not all participants in Pacific test operations were film badged. Usually only participants who entered radex (radiation exclusion) areas were film badged. For Redwing and subsequent Pacific testing operations, all test participants were provided film badges by issuing blocks of numbered badges to leaders in participating groups who were in turn responsible for reissuing them to their personnel and assuring return of the badges for processing.

b. The Pacific records were compiled from several sources including test operation exposure reports, nontesting period interim reports, quarterly records, and individual film badge reports in some cases. Thus, several records for the same individual may appear in a given year. Also, since not all participants were film badged prior to 1956, not all personnel who may have been exposed are in the records for this period.

c. Prior to 1957 on the U.S. continent, not all participants were issued film badges. Thus, for 1945 through 1956, not all personnel who were exposed are in the records. As in the Pacific, continent records for this period were compiled from several sources, and more than one record for an individual may appear in a given year.

d. Beginning January 1, 1957, AEC film badged all personnel who entered the NTS with a security badge. Thus, all NTS personnel, including 1957 to the present, who entered NTS through a security gate were required to wear a film badge, and each person appears only once per year in the records. However, most observers who did not enter test areas prior to and including 1957 were not issued film badges and do not appear in the records.

e. Desert Rock troops who participated in NTS exercises during 1951, 1952, 1953, 1955, and 1957 did not wear NTS film badges except for the few hundred personnel who were issued NTS security badges. During 1951 and 1952, Desert Rock troops entering test areas had been issued film badges by the Army at Camp Desert Rock which was off the NTS several miles south of Camp Mercury, the main entrance to NTS. Troops were passed through the security gates entering and leaving NTS in convoys for all of the above years of Desert Rock exercises. The 1951 and 1952 Desert Rock film badge results were obtained by REECo from the Lexington Army Signal Depot in about 1967 during a project intended to centralize weapons testing exposure records in one file at NTS. Thus, these records are in the current file.

f. Desert Rock troops participating in NTS exercises during 1953 and 1955 were convoyed in and out as above but were not issued one film badge per individual by the Army. Reportedly, one badge per platoon or company was issued by the Army for monitoring purposes. We do not believe we have these film badge results in the file, but we do have some rosters of convoyed troops in our archives, which are currently being evaluated.

g. In 1957, participating Desert Rock troops again were issued film badges at Desert Rock by the Army on an individual basis. In the early 1970's during a reorganization and automation of the records system, AEC obtained microfilms of about 20,000 records located at Lexington Army Signal Depot, and these 1957 records are in the current file.

h. While all NTS personnel with NTS security badges have been required to wear film badges from 1957 to the present, there have been a few instances of participants flying over the NTS without NTS film badges and subsequently receiving radiation doses from effluent clouds. Some of these personnel wore film dosimeters from another installation. Records of such exposures are in our file, but the completeness of the record is not known. A very few, perhaps 10 or 20 personnel, were not wearing dosimeters or we have not been notified of their exposures for inclusion in the file.

i. All of the exposure records are on file in a computer and in microfilms. Programs can be written for the computer which will allow retrieval of the data limited by the amount of identification information available in the records.

DOE intends to propose by publication in the Federal Register a revision which would modify its Privacy Act System "ERDA-30" to add additional routine uses for information in that system, i.e. exposure records. This revision would permit disclosure for certain specific purposes to the Department of Defense, Center for Disease Control (HEW) and National Academy of Science.

Topic A-4

Q: Advise the Committee about BANEBERRY followup situation including the number of persons still employed, what is being done about their medical followup, what is being done about followup for those no longer employed.

A: At present, the identities of many of the 900 personnel evacuated from the Area 12 vicinity following the BANEBERRY Event have been established. Efforts are continuing to complete this identification through housing records, job assignment rosters and time card records. In the process of completing this exercise, we will learn the number of these indiviudals who are still employed in weapons testing matters at Nevada.

As indicated in testimony on February 14, 1978, all personnel, who are employed by DOE or its contractors in activities involving potential exposure to radiation, are receiving medical surveillance in a program that has been in effect since 1971. At this time, DOE is adopting the policy that any present or former employee, who has a documented past radiation exposure from nuclear weapons testing above the current guidelines of 5.0 rem/year or 3.0 rem/quarter, and who did not receive medical attention comparable to that now provided to NTS workers, is offered a medical examination.

A (Testimony presented on February 14, 1978, furnished most of the requested information; however, some additional information now is available.) –

Based upon a careful check of all known records, there were 873 individuals present in Area 12 of the NTS during the BANEBERRY incident. Out of these, 305 are still in the same employment as they were in 1970. For the 873 persons who were present, film badge records indicate that 9 individuals received between 0.5 rem and 1.0 rem, 25 received between 0.2 rem and 0.5 rem, and 114 received doses between 0.03 rem and 0.2 rem.

Topic A-5

Q: Explain the relationship between the 900 possible exposures on BANEBERRY, the 86 who had detected contamination, and the 3 leukemias. Mention the guidelines, the exposure records, and the results of scans to determine internal exposures and what has been done about followup.

A: a. The security-controlled exclusion area for the Baneberry event at the north end of Yucca Flat and the NTS did not include Area 12 or the bypass road from the rest of NTS. Personal vehicles and government pickups, sedans, and buses were used by workers traveling to work in Area 12 the morning of the Baneberry event.

Residents of the Area 12 Camp were reporting to work at various Area 12 sites or tunnels, awaiting permission to reenter the Area 2 construction yard in the exclusion area, or reporting to other NTS work locations. Thus, with no mustering or accountability system in effect for personnel in Area 12, we can only estimate that approximately 900 personnel were at various locations in Area 12 or on their way to and from work locations at the time of the Baneberry event.

Of the approximately 900 personnel who were in Area 12 or who arrived to assist in the evacuation, the number who were in the effluent cloud which moved into the Area 12 Camp is uncertain. Many personnel were working underground at the various tunnels and some were working or traveling to work at some distance from Camp 12.

When the evacuation commenced, some personnel had left Area 12 for other NTS locations. Vehicles evacuating personnel were joined in a convoy in Area 17 before traveling to the Control Point for monitoring and decontamination as necessary. A total of 475 vehicles were monitored at the Control Point on the day of the event (by security personnel count), 413 were contaminated, decontamination and release of 380 was accomplished, and 33 vehicles were impounded pending decay of radioactivity.

Personnel were monitored while their vehicles were monitored. Personnel with detectable contamination were taken into the Rad-Safe Building CP-2 for additional monitoring and superficial decontamination including brushing and use of tape patches to remove slight contamination. Clothing was taken from 106 persons, and these personnel were monitored for skin and hair contamination, decontaminated by showering if necessary, and provided clean clothing. Of the 106 persons, 86 were required to shower. After remonitoring, 68 were sent to Mercury for additional decontamination and direct measurement of thyroid radioactivity. Urine samples were taken and analyzed for many of these personnel. Of the personnel thyroid-counted in Mercury, 18 were sent to EPA in Las Vegas where whole-boyd counts were performed.

b. After evaluating all film badge results, thyroid counts, whole-body counts, and urine sample results, it was concluded that no individuals received external or internal dose in excess of the AEC exposure guides. The whole-body penetrating radiation guides (AECM-0524) during Baneberry were 3 rem per calendar quarter and 5(N-18) rem per year (where N is the person's age in years). The guide in effect for the skin of the whole body and the thyroid was 10 rem per quarter and 30 rem per year.

c. Three persons known or purported to have been exposed to radioactivity from the Baneberry event have reportedly contracted leukemia. Information concerning these individuals and their NTS radiation exposure records is summarized below:

(1) H. R. Roberts, a WSI security guard, received a total of 300 mrem whole-body penetrating gamma radiation dose and no other dose at NTS from 1966 until the Baneberry event as determined from film badge dosimetry. His doses from exposure during the Baneberry event were 900 mrem whole-body gamma (determined from evaluation of his contaminated film badge which indicated 1045 mrem), 4435 mrem beta dose to the skin (including contamination darkening of the dosimeter film), and 3680 mrem to the thyroid. He received no reportable radiation doses at NTS after the Baneberry event as determined by film badge dosimetry.

(2) W. H. Nunamaker, a REECo employee, recieved gamma doses at NTS as follows and no other doses until the Baneberry event:

Year	Dose (mrem)
1958	665
1962	1085
1963	380
1966	330
1967	40

His doses from exposure during the Baneberry event were 105 mrem whole-body gamma, 430 mrem beta dose to the skin, and 650 mrem to the thyroid. He received no additional radiation dose at NTS after the Baneberry event.

(3) W. C. Reed, a REECo employee, received the following gamma and beta doses at NTS prior to the Baneberry event:

Year	Gamma (mrem)	Beta (mrem)
1957	1275	
1958	115	
1962	2025	
1963	40	
1966	3560	6265
1967	495	960
1968	310	530
1969	40	

He received no reportable radiation exposure from the Baneberry event as determined by film badge dosimetry. He was not among the group of personnel found to be contaminated, decontaminated, or thyroid-counted after Baneberry. His total dose at NTS after Baneberry was 40 mrem gamma determined by film badge dosimetry. It is noted that Mr. Reed is known to have been working in the forward NTS area during Baneberry, but his specific work location or whether he was in the Area 12 Camp is not known at this time.

d. One person known to have been in the Area 12 Camp during Baneberry contracted lymphoma and is now deceased. P. A. Crawford, a REECo employee, recieved the following gamma doses prior to the Baneberry event:

Year	Dose (mrem)
1962	1225
1963	455
1965	240
1966	145

He received no reportable exposure during the Baneberry event. Monitoring personnel found a spot of contamination on one sleeve which was removed. His clothing was not removed, he was not required to shower, and he was not thyroid-counted. His total exposure at NTS after Baneberry was 40 mrem gamma. It is noted that a REECo physician is of the opinion that the lymphoma existed prior to Baneberry, based on results of a physical examination of Mr. Crawford some two months before Baneberry.

e. The general statement can be made regarding medical followup histories that we have not conducted medical followups of persons exposed during Baneberry because none were exposed in excess of the established AEC exposure standards. There existed no basis for selecting personnel exposed during Baneberry for medical followups when a large number of NTS personnel had received similar or larger doses in the past without medical followups.

However, DOE/NV will make a concerted effort to determine the names of as many personnel as possible who were exposed during Baneberry, and institute a medical followup program for any of these personnel exposed above the guideline levels.

Topic A-6

Q Clarify for the record the numbers and status of participants at NTS tests (also Pacific). Try to provide a breakout of military. Clear up the point of multiple dosimetry records.

A The information listed for Question A-3. clarifies the numbers of participants at NTS and Pacific tests to the extent of exposure records available to REECo. We are unable to identify the military/civilian status of participants at this time. However, a current dosimetry records project includes research and writing of computer programs which will permit retrieval of records by organization within each year for those years where this identification information is in the records.

This computer retrieval primarily is intended to separate military and civilian personnel where possible. However, all the records do not identify military personnel by rank, service number, organization, ship, or location, or by other means which would allow segregation of records. This is particularly the case where military personnel were assigned to work under civilian testing laboratories and are identified under those organizations. The records project is budgeted for this fiscal year, and additional funds have been requested for the next two fiscal years. The project also includes compiling a history of personnel dosimetry for all nuclear testing in the Pacific and on the U.S. continent.

A complication in the existing files is brought about because of "multiple dosimetry records." Essentially, multiple records means that one individual may appear more than once per year in the Pacific records and in NTS records prior to 1957. These usually are not duplications, but represent different exposures. For example, one individual may be listed for a test operation period and for an interim period in the same year, or for each calendar quarter in a nontesting year.

It bears repeating that there were probably many military personnel present during the Pacific test series for whom no exposure records appear in REECo files.

Topic A-7

Q. Summarize for the last 10 years research projects by year which relate to low-level radiation effects on humans. Indicate project with a brief description, dollar level, who is doing the project and of what agency.

A. The following studies have been done with relation to biological effects of low level ionizing radiation on humans.

	($ in Thousands)
Argonne National Laboratory	
Radium Studies - A. F. Stehney	$2600
A study of a large group of people that acquired appreciable body burdens of radium by occupational exposure and from medical administration. About four years ago, a study of thorium workers were initiated.	
Brookhaven National Laboratory	
Medical Studies of Marshall Islanders - R. A. Conard	420
Follow-up of Marshallese exposed to fallout from nuclear weapons testing.	
Los Alamos Scientific Laboratory	
Plutonium in Tissue Study - J. F. McInroy	264
Actual measurement of tissue depositions of plutonium in workers to verify the accuracy of estimated body deposition based on bioassay.	
Health of LASL Plutonium Workers - G. L. Voelz	405
Epidemiological study of mortality and morbidity of all Pu-workers in the U.S. since 1944.	
Oak Ridge National Laboratory	
Public Health and Demographic Studies - D. J. Jacobs	75
Mortality trends in populations surrounding nuclear installations.	
Pacific Northwest Laboratory	
Statistical Health Effect Studies - E. Gilbert	100
Analysis of the mortality of Hanford workers.	
Oak Ridge Associated Universities	
Health and Mortality Study - E. Tompkins	480
Analysis of the mortality of Oak Ridge workers.	
Radiation Emergency Assistance Center - C. Lushbaugh	741
Center for treatment of radiation accident victims and registry and follow-up of accidental exposures over 25 rad.	
Hanford Environmental Health Foundation	
Health and Mortality Study - B. Breitenstein	135
Record collection on dosimetry of Hanford workers.	
U. S. Transuranium Registry - B. Breitenstein	240
Repository for health and exposure data for persons occupationally exposed to transuranium elements.	

Japan	
Radiation Effects Research Foundation - L. Allen	6393
Formerly the Atomic Bomb Casualty Commission, a follow-up of Japanese survivors in Hiroshima and Nagasaki.	
Nevada Operations Office	
Personnel Exposures at Nevada Test Site - REECO	250
Central repository for medical and exposure history of participants at weapons test site.	
St. Mary's Hospital - Grand Junction, Colorado	
Uranium Miner Lung Cancer Study - G. Saccomanno	120
Followup of uranium miners in the Colorado Plateau; study of changes in sputum cytology.	
University of Rochester	
Biological Effects of Ionizing Radiation - L. Hempelmann	52
Project includes medical follow-up of 25 plutonium workers with high depositions.	
Brazil	
Studies of Population in High Background Area - P. Franco	14
Studies of population living in areas of high natural background	
University of North Carolina	
Chest Fluoroscopy and Neoplasia - M. C. Battigelli	50
Incidence of neoplasia in tuberculosis patients subjected to repeated fluoroscopy for pneumothorax and pneumoperitoneum	
University of Denver	
Cytogenetic Study of Workers Exposed to Radon-222 and Plutonium-239 - W. F. Brandom	110
Study of chromosome abnormalities in uranium miners and workers in Rocky Flats	
University of California-Los Angeles	
Radiation Effects on Immunologic Parameters - T. Makinodan	203
Late radiation effects on various immunologic parameters in Japanese survivors	
Total FY 1978	$ 12,652

Q List DOE research projects conducted during the last 10 years which relate to low-level radiation effects. Indicate project with a brief description, dollar level, who is doing the project and at what agency.

A A partial response to this question, which was furnished on February 8, 1978, described the projects and furnished most of the requested information. Attached is a tabulation by year of the project funding over the past ten years. This should be appended to the February 8, 1978, response to this question.

ADDENDUM TO TOPIC A-7

2/9/78

LOW LEVEL RADIATION EFFECTS ON HUMANS
(Dollars in thousands - B/O)

	Actual										Estimate
	FY 1968	FY 1969	FY 1970	FY 1971	FY 1972	FY 1973	FY 1974	FY 1975	FY 1976	FY 1977	FY 1978
ANL - Radium Studies (Stehney)	$ 0	$ 45	$ 310	$ 881	$ 1,436	$ 1,925	$ 2,121	$ 2,206	$ 2,398	$ 2,470	$ 2,600
BNL - Medical Studies of Marshall Islanders (Conard)	124	125	145	143	189	216	247	287	393	390	420
LASL - Plutonium in Tissue Study (McInroy)	0	0	0	25	37	75	95	201	223	266	264
LASL - Health of LASL Plutonium Workers (Voelz)	0	0	0	0	0	0	0	41	54	194	405
ORNL - Public Health and Demographic Studies (Jacobs)	0	0	0	0	0	0	0	51	65	75	75
PNL - Statistical Health Effects Studies (Gilbert)	0	0	0	0	0	0	0	0	100	90	100
ORAU - Health and Mortality Study (Tompkins)	0	0	0	0	0	0	0	0	0	35	480
U. of Pittsburgh - Health and Mortality Study (Mancuso)	0	94	115	79	117	192	190	213	411	0*	0*
ORAU - Radiation Emergency Assistance Center (Lushbaugh)	0	0	0	0	0	0	0	0	398	598	741
HEHF - Health and Mortality Study (Breitenstein)	0	0	0	68	43	60	69	84	139	135	135
HEHF - U.S. Transuranium Registry (Breitenstein)	5	55	75	80	82	80	61	90	111	111	240
RERF - Japan (Allen)	3,662	3,821	4,130	4,516	5,000	5,535	6,053	7,376	5,255	6,311	6,348
NVO - Personnel Exposures at Nevada Test Site (REECO)	0	0	0	0	0	0	0	0	0	0	250
St. Mary's Hospital - Uranium Miner Lung Cancer Study (Saccomanno)	0	39	30	39	39	23	39	94	149	121	120
U. of Rochester - Biological Effects of Ionizing Radiation (Hempelmann)	0	0	0	42	0	40	43	50	53	66	52
Federal U. of Rio de Janeiro, Brazil - Studies of Population in High Background Area (Franca)	17	23	0	11	19	3	0	7	0	0	14
U. of North Carolina - Chest Fluoroscopy and Neoplasia (Battigelli)	0	0	0	0	15	10	60	64	50	50	50
U. of Denver - Cytogenetic Study of Workers Exposed to Radon-222 and Plutonium-239 (Brandom)	0	0	0	0	0	0	0	0	115	144	110
U. of California - Radiation Effects on Immunologic Parameters (Makinodan)	0	0	0	0	0	0	0	0	0	203	203
TOTAL	$ 3,808	$ 4,202	$ 4,805	$ 5,884	$ 6,977	$ 8,159	$ 8,978	$10,764	$ 9,914	$11,259	$12,607

*Transferred to ORAU, above.

Topic A-8

Q. Summarize the follow-up being done for natives of Rongelap and Utirik along the lines of the Committee's questions.

A. Compensation has been arranged for certain inhabitants of the Marshall Islands through the following two bills, copies of which are attached:

1. Public Law 88.485, [H.R. 1988], August 22, 1964, authorized payment by the Secretary of the Interior of $950,000 less legal fees for legal services to the 82 inhabitants of Rongelap, or to their survivors, affected by radiation exposure sustained following the thermonuclear detonation of March 1, 1954. Each exposed individual or his heirs received approximately $11,000 as a lump sum.

The people of Utirik received no compensation under this legislation.

2. Public Law 95-134 [H.R. 6550], October 15, 1977, authorized payment by the Secretary of the Interior to compensate inhabitants of Rongelap Atoll and Utirik Atoll for radiation exposures sustained March 1, 1954.

PACIFIC ISLANDS TRUST TERRITORY—CLAIMS

PUBLIC LAW 88-485; 78 STAT. 598

[H. R. 1988]

An Act to provide for the settlement of claims of certain residents of the Trust Territory of the Pacific Islands.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That:

The Congress hereby assumes compassionate responsibility to compensate inhabitants in the Rongelap Atoll, in the Trust Territory of the Pacific Islands, for radiation exposures sustained by them as a result of a thermonuclear detonation at Bikini Atoll in the Marshall Islands on March 1, 1954.

Sec. 2. There is authorized to be appropriated for such purpose out of the Treasury of the United States the sum of $950,000 to be expended by the Secretary of the Interior (hereinafter referred to as the "Secretary") in the manner hereinafter provided. After deducting the amount provided for in section 5 hereof, the Secretary shall pay the remainder in equal amounts to each of the affected inhabitants of Rongelap, except that (a) with respect to each such inhabitant who has died before receipt of such payment, the Secretary shall pay such sum to the heirs or legatees of such inhabitant, and (b) with respect to any such inhabitant who is less than twenty-one years of age or who has been adjudged incompetent or insane, payment shall be made, in the discretion of the Secretary, to a parent, relative, other person, or institution for his benefit.

Sec. 3. The Secretary shall give advice concerning prudent financial management to each person receiving a payment pursuant to this Act, to the end that each such person will have information as to methods of conserving his funds and as to suitable objects for which such funds may be expended.

Sec. 4. A payment made under the provisions of this Act shall be in full settlement and discharge of all claims against the United States arising out of the thermonuclear detonation on March 1, 1954.

Sec. 5. The Secretary is authorized to pay reasonable attorney fees for legal services rendered on behalf of the people of Rongelap prior to the date of enactment of this Act. Such fees shall be paid out of the funds authorized to be appropriated in section 2 of this Act, but the total of such fees paid shall not exceed 5 per centum of the appropriated funds.

Sec. 6. The decisions of the Secretary in carrying out the provisions of this Act shall be final and not subject to review.

Approved August 22, 1964.

This came to about $10,000 per person for fallout victims on Rongelap! Utirik got nothing.

Interior refers to this as "ex-gratia" payment; i.e. as a matter of grace, favor, or indulgence; gratuitous.

PUBLIC LAW 95-134 [H.R. 6550]; Oct. 15, 1977

AUTHORIZATION, APPROPRIATION—U.S. TERRITORIES

For Legislative History of Act, see p. 4544

An Act to authorize certain appropriations for the territories of the United States, to amend certain Acts relating thereto, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

Territories of the United States. Appropriation authorization.

TITLE I

Trust Territory of the Pacific Islands. 48 USC 1681 note.

Sec. 101. (a) Section 2 of the Act of June 30, 1954 (68 Stat. 330), as amended, is further amended by changing "and such amounts as were authorized but not appropriated for fiscal year 1975," to read "and such amounts as were authorized but not appropriated for fiscal years 1975, 1976, and 1977: for fiscal year 1978, $90,000,000; for fiscal year 1979, $122,700,000; for fiscal year 1980, $112,000,000;".

(b) Section 2 of the Act of June 30, 1954 (68 Stat. 330), as amended, is further amended by (1) deleting "but not to exceed $10,000,000," and (2) deleting all of the language beginning with the words "which amounts for each fiscal year" up to and including the words "calendar year 1974,".

Northern Mariana Islands. 48 USC 1681 note.

Sec. 102. Until the provisions of the covenant to establish a Commonwealth for the Northern Mariana Islands (90 Stat. 263) have been met and approved as required in section 1003(b) thereof, there is hereby authorized to be appropriated $13,515,000 for the government of the Northern Mariana Islands. When such conditions are met, the appropriations authorized in article VII, section 704, of said covenant shall become effective.

Enewetak Atoll.

Sec. 103. For the rehabilitation and resettlement of Enewetak Atoll in the Trust Territory of the Pacific Islands there is hereby authorized to be appropriated $12,400,000 (July 1976 prices) plus or minus such amounts, if any, as may be justified by reason of ordinary fluctuations in construction costs as indicated by engineering cost indexes applicable to the types of construction involved.

Rongelap Atoll and Utirik Atoll. Radiation victims.

Sec. 104. (a) In addition to appropriations authorized to compensate inhabitants of Rongelap Atoll and Utirik Atoll in the Trust Territory of the Pacific Islands for radiation exposure sustained by them as a result of a thermonuclear detonation at Bikini Atoll in the Marshall Islands on March 1, 1954, pursuant to the Act of August 22, 1964 (78 Stat. 593), effective October 1, 1977, there are authorized to be appropriated such amounts as may be necessary to carry out the provisions of this section and the Secretary of the Interior (hereafter in this section referred to as the "Secretary") is authorized and directed to make the payments as hereafter provided in this paragraph to individuals, or to their heirs or legatees, as the case may be, who were on March 1, 1954, residents on Rongelap Atoll or Utirik Atoll in the Marshall Islands:

Payments to heirs or legatees.

(1) The Secretary shall pay $25,000 to each such individual from whom the thyroid gland or a neurofibroma in the neck was surgically removed, or who has developed hypothyroidism, or who develops a radiation-related malignancy, such as leukemia.

(2) The Secretary shall pay $1,000 to each individual who, on such date, was a resident on Utirik Atoll.

(3) Where circumstances warrant, as he shall determine, the Secretary shall pay an amount not in excess of $25,000 as he determines to be an appropriate compassionate compensation to each such individual who has suffered any physical injury or harm from a radiation-related cause but who is not an individual described in paragraph (1).

Medical care and treatment.

(4) In addition to the payments provided in paragraphs (1), (2), and (3) of this subsection, the Secretary shall provide by appropriate means adequate medical care and treatment for any person who has a continuing need for the care and treatment of any radiation injury or illness directly related to the thermonuclear detonation referred to in paragraph (a) of this section.

Costs.

The costs of such medical care and treatment shall be assumed by the Administrator of the Energy Research and Development Administration.

Report to congressional committees.

(5) Not later than December 31, 1980, the Secretary shall report to the appropriate committees of the United States Congress for their consideration what, if any, additional compassionate compensation may be justified for those individuals continuing to suffer from injuries or illnesses directly related to radiation resulting from the thermonuclear detonation referred to in paragraph (a) of this section.

Additional payment, limitation.

one boy's parents

In the case of the demise of any individual entitled to receive payment under this section who expires before receiving such payment, the Secretary shall pay the amount which that individual would have been entitled to receive under this section to the heirs or legatees of such individual, in accordance with an appropriate method of distribution, per stirpes, and not per capita. Where the demise of any individual eligible for payment under paragraph (1) or (3) supra is directly related to the thermonuclear detonation referred to in paragraph (a) of this section, the Secretary may make an additional compassionate payment not to exceed $100,000 to the heirs or legatees of such individual. In determining the amount of such payment the Secretary shall consider, but is not limited to, the following: any payments which the deceased has received or would have been eligible to receive under this section, and loss of support, services, or contributions to the heirs or legatees.

Rongelap, Utirik, and Bikini Atolls, sums for community purposes.

(b) For the use of each of the island communities of Rongelap, Utirik, and Bikini Atolls there is authorized to be appropriated $100,000. Such funds are to be paid by the Secretary, in conjunction with guidelines to be established by the High Commissioner of the Trust Territory of the Pacific Islands, for such community purposes as the municipal councils of such island communities may direct.

(c) A payment made under the provisions of this section shall be in full settlement and discharge of all claims against the United States arising out of the thermonuclear detonation on March 1, 1954.

(d) The decisions of the Secretary in allowing or denying any claim for payment under this section shall be final and conclusive on all questions of law and fact and not subject to review by any other official of the United States, or by any court by mandamus or otherwise.

Rules and regulations.

(e) The Secretary is authorized to make such rules and regulations as he determines necessary to carry out the provisions of this section.

Adjudicated claims and final awards.
50 USC app. 2018.

Sec. 105. In addition to amounts heretofore authorized pursuant to the Micronesian Claims Act of 1971 (85 Stat. 96), there are hereby authorized to be appropriated to the Secretary of the Interior such sums as may be necessary to satisfy all adjudicated claims and final awards made by the Micronesian Claims Commission to date un-title I and title II of said 1971 Act, for full payment of such awards: *Provided*, That no sums appropriated pursuant to this section may be paid on awards pursuant to title I of said 1971 Act until, subsequent to the date of enactment of this section, the Government of Japan has provided to the Government of the Trust Territory of the Pacific Islands a contribution, which contribution may be in goods and services, which has a value as determined by the Secretary of the Interior equivalent to not less than 50 per centum of the total awards made pursuant to title I of said 1971 Act less $10,000,000 from such total: *Provided further*, That prior to making any payment on an award pursuant to either title I or title II of said 1971 Act, the Secretary shall review such award and determine whether any portion of such award constitutes interest not authorized to be awarded under the said 1971 Act and shall exclude from his payment such amounts as he determines constitute such interest. The Secretary's determination of the proportion of any award which constitutes such interest and the proportion which constitutes value shall be final and shall not be subject to judicial review.

50 USC app. 2019, 2020.

Contribution by Government of Japan.

Award, review.

TITLE II

Sec. 201. (a) There is hereby authorized to be appropriated to the Secretary of the Interior (hereinafter referred to as the Secretary), not to exceed $15,000,000 for a grant to the Government of Guam to assist in typhoon rehabilitation, upgrading and construction of public facilities, and maintenance of essential services.

Government of Guam.

(b) Funds provided under this Act may be used by Guam as its matching share for Federal programs and services.

(c) The Government of Guam in carrying out the purpose of this Act may utilize, to the extent practicable, the available services and facilities of agencies and instrumentalities of the United States Government on a reimbursable basis. Reimbursements may be credited to the appropriation or fund which provided the services and facilities. Agencies and instrumentalities of the United States Government may, when practicable, make available to the Government of Guam upon request of the Secretary such services and facilities as they are equipped to render or furnish, and they may do so without reimbursement if otherwise authorized by law.

Services and facilities of U.S. Government, utilization.

(d) The Secretary may place such stipulations as he deems appropriate on the use of funds appropriated pursuant to section 301(a).

Post, p. 1162.

Sec. 202. Section 2 of the Guam Development Fund Act of 1968 (82 Stat. 1172; 48 U.S.C. 1428) is amended by changing "Sec. 2." to "Sec. 2. (a)" and adding at the end thereof the following new subsection (b):

"(b) In addition to the appropriations authorized in subsection (a), $1,000,000 is authorized to be appropriated to the Secretary of the Interior to be paid to the Government of Guam annually for five fiscal years commencing in fiscal year 1978 to carry out the purposes of this Act.".

Additional appropriation authorizations.

Sec. 203. The Organic Act of Guam (64 Stat. 394) as amended (48 U.S.C. 1421 et seq.) is further amended:

(a) by deleting from the first sentence of section 9-A(a) everything after the words "government of Guam"; adding a period after "Guam"; and inserting the following sentence: "Effective October 1, 1977, the salary and expenses of the Comptroller's office shall be paid from funds authorized to be appropriated to the Department of the Interior.";

Government comptroller, salary and expenses.
48 USC 1422d.

48 USC 1681b.

(b) the Act of June 30, 1954 (68 Stat. 330), as amended, is further amended by deleting the last sentence of section 4(a);

Separate tax. 48 USC 1421i.

(c) by changing the period at the end of section 31(a) to a colon and inserting the following: "*Provided*, That notwithstanding any other provision of law, the Legislature of Guam may levy a separate tax on all taxpayers in an amount not to exceed 10 per centum of their annual income tax obligation to the Government of Guam.".

District Court of Guam, review of claims. 48 USC 1424c.

SEC. 204. (a) Notwithstanding any law or court decision to the contrary, the District Court of Guam is hereby granted authority and jurisdiction to review claims of persons, their heirs or legatees, from whom interests in land on Guam were acquired other than through judicial condemnation proceedings, in which the issue of compensation was adjudicated in a contested trial in the District Court of Guam, by the United States between July 21, 1944, and August 23, 1963, and to award fair compensation in those cases where it is determined that less than fair market value was paid as a result of (1) duress, unfair influence, or other unconscionable actions, or (2) unfair, unjust, and inequitable actions of the United States.

Land acquisitions effected through judicial condemnation proceedings.

(b) Land acquisitions effected through judicial condemnation proceedings in which the issue of compensation was adjudicated in a contested trial in the District Court of Guam, shall remain res judicata and shall not be subject to review hereunder.

Fair compensation.

(c) Fair compensation for purposes of this Act is defined as such additional amounts as are necessary to effect payment of fair market value at the time of acquisition, if it is determined that, as a result of duress, unfair influence, or other unconscionable actions, fair market value was not paid. Interest may not be allowed from the time of acquisition to the date of the award on such additional amounts as may be awarded pursuant to this section.

Special masters or judges, employment.

(d) The District Court of Guam may employ and utilize the services of such special masters or judges as are necessary to carry out the intent and purposes hereof.

(e) Awards made hereunder shall be judgments against the United States.

Attorney's fees, limitation.

(f) Attorney's fees paid by claimants to counsel representing them may not exceed 5 per centum of any additional award. Any agreement to the contrary shall be unlawful and void. Whoever, in the United States or elsewhere, demands or receives any remuneration in excess of the maximum permitted by this section shall be guilty of a misdemeanor and, upon conviction thereof, shall be fined not more than $5,000 or imprisoned not more than twelve months, or both. A reasonable attorney's fee may be awarded in appropriate cases.

Violation, penalty.

(g) All agencies and departments of the United States Government shall, upon request, deliver to the court any documents, records, and writings which are pertinent to any claim under review.

Grants to Government of Guam.

SEC. 205. There is hereby authorized to be appropriated to the Secretary of the Interior such sums as may be necessary for grants to the Government of Guam to meet the health care needs of Guam, but not to exceed $25,000,000: *Provided*, That no grant may be made by the Secretary of the Interior pursuant to this section without the prior approval of the Secretary of Health, Education, and Welfare.

TITLE III

Government comptroller, salaries and expenses.

SEC. 301. (a) The Revised Organic Act of the Virgin Islands (68 Stat. 501) as amended (48 U.S.C. 1599) is further amended as follows: Delete from the first sentence of section 17(a) everything after the words "government of the Virgin Islands", add a period after "Virgin Islands" and insert the following sentence: "Effective October 1, 1977, the salary and expenses of the Comptroller's office shall be paid from funds authorized to be appropriated to the Department of the Interior.".

(b) Section 9(d) of the Revised Organic Act of the Virgin Islands (68 Stat. 497; 48 U.S.C. 1541 et seq.) is amended by inserting immediately before the period at the end thereof the following: ", unless the legislature, after reconsideration upon motion of a member thereof, passes such items, parts, or portions so objected to by a vote of two-thirds of all the members of the legislature."

Legislative procedure.
48 USC 1575.

(c) Section 8 of the Revised Organic Act of the Virgin Islands (48 U.S.C. 1574) is amended by adding at the end thereof the following new subsection:

"(f)(1) The Legislature of the Virgin Islands may impose on the importation of any article into the Virgin Islands for consumption therein a customs duty. The rate of any customs duty imposed on any article under this subsection may not exceed—

Customs duty.

Rate, limitation.

"(A) if an ad valorem rate, 6 per centum ad valorem; or

"(B) if a specific rate or a combination ad valorem and specific rate, the equivalent or 6 per centum ad valorem.

"(2) Nothing in this subsection shall prohibit the Legislature of the Virgin Islands from permitting the duty-free importation of any article.

Duty-free importation.

"(3) Nothing in this subsection shall be construed as empowering the Legislature of the Virgin Islands to repeal or amend any provision in law in effect on the day before the date of the enactment of this subsection which pertains to the customs valuation or customs classification of articles imported into the Virgin Islands.".

TITLE IV

SEC. 401. The Secretary of the Interior is directed to submit to the Congress not later than January 1, 1978. a report on Federal programs available to the territories of the United States indicating in such report what programs are available to each territory, what additional programs would be of benefit to such territory if made available, what changes or modifications to each program should be made to improve the operation and effectiveness of each program and the estimated costs of such program. There is hereby authorized to be appropriated for fiscal year 1978 $50,000 to assist the Secretary in the preparation of this report.

Federal programs, availability to U.S. territories.
Report to Congress.
43 USC 1457 note.

SEC. 402. In order to compensate the territories of Guam and the Virgin Islands for unexpected revenue losses occasioned by the Tax Reduction Act of 1975 and the Tax Reform Act of 1976 there is hereby authorized to be appropriated to the Secretary for grants to the government of Guam not to exceed $15,000,000 and after October 1, 1977, for grants to the government of the Virgin Islands not to exceed $14,000,000, such sums being in addition to those previously authorized for such purposes.

Guam and the Virgin Islands.
26 USC 7651 note.
26 USC 1 note.

SEC. 403. Effective on the date of enactment of this Act, those laws, except for any laws administered by the Social Security Administration and except for medicaid which is now administered by the Health Care Financing Administration, which are referred to in section 502(a)(1) (except for the reference to the Micronesian Claims Act of 1971 (85 Stat. 96)) of the Covenant to Establish a Commonwealth of the Northern Mariana Islands in Political Union With the United States of America, approved by joint resolution approved on March 24,

48 USC 1681 note.

90 Stat. 268.
50 USC app. 2018.

1976 (90 Stat. 263), and 502(a)(2) of said Covenant shall be applicable to the territories of Guam and the Virgin Islands on the same terms and conditions as such laws are applied to the Commonwealth of the Northern Mariana Islands.

TITLE V

Insular Areas.
48 USC 1469a.

SEC. 501. In order to minimize the burden caused by existing application and reporting procedures for certain grant-in-aid programs available to the Virgin Islands, Guam, American Samoa, the Trust Territory of the Pacific Islands, and the Government of the Northern Mariana Islands (hereafter referred to as "Insular Areas") it is hereby declared to be the policy of the Congress that:

Consolidation of grants.

(a) Notwithstanding any provision of law to the contrary, any department or agency of the Government of the United States which administers any Act of Congress which specifically provides for making grants to any Insular Area under which payments received may be used by such Insular Area only for certain specified purposes (other than direct payments to classes of individuals) may, acting through appropriate administrative authorities of such department or agency, consolidate any or all grants made to such area for any fiscal year or years.

(b) Any consolidated grant for any insular area shall not be less than the sum of all grants which such area would otherwise be entitled to receive for such year.

Allocation of funds.

(c) The funds received under a consolidated grant shall be expended in furtherance of the programs and purposes authorized for any of the grants which are being consolidated, which are authorized under any of the Acts administered by the department or agency making the grant, and which would be applicable to grants for such programs and purposes in the absence of the consolidation, but the Insular Areas shall determine the proportion of the funds granted which shall be allocated to such programs and purposes.

Grants-in-aid regulations; publication in Federal Register.

(d) Each department or agency making grants-in-aid shall, by regulations published in the Federal Register, provide the method by which any Insular Area may submit (i) a single application for a consolidated grant for any fiscal year period, but not more than one such application for a consolidated grant shall be required by any department or agency unless notice of such requirement is transmitted to the appropriate committees of the United States Congress together with a complete explanation of the necessity for requiring such additional applications and (ii) a single report to such department or agency with respect to each such consolidated grant: *Provided*, That nothing in this paragraph shall preclude such department or agency from providing adequate procedures for accounting, auditing, evaluating, and reviewing any programs or activities receiving benefits from any consolidated grant. The administering authority of any department or agency, in its discretion, may (i) waive any requirement for matching funds otherwise required by law to be provided by the Insular Area involved and (ii) waive the requirement that any Insular Area submit an application or report in writing with respect to any consolidated grant.

Waivers.

Approved October 15, 1977.

LEGISLATIVE HISTORY:

HOUSE REPORT No. 95-228 (Comm. on Interior and Insular Affairs).
SENATE REPORT No. 95-332 (Comm. on Energy and Natural Resources).
CONGRESSIONAL RECORD, Vol. 123 (1977):
- May 2, considered and passed House.
- July 25, considered and passed Senate, amended.
- Sept. 27, House agreed to certain Senate amendments with amendments.
- Sept. 28, Senate concurred in House amendments with an amendment.
- Sept. 29, 30, House concurred in Senate amendment with an amendment.
- Sept. 30, Senate concurred in House amendment.

Topics A-9

Q Report on the total exposure record level and findings as to the total over-exposures observed. Any breakout by test series might be helpful if such a breakout is feasible without great extra effort.

Q How many people suffered excessive radiation exposures in the Nevada testing program and in the Pacific testing program by year (1946 to present)?

A (Information has been obtained in response to Topic A-9 and in addition to our previous response to Topic B-8a.)

Based upon available records, there have been a total of 2156 individuals, involved in testing, for whom there are film badge readings of whole-body gamma radiation exposure in excess of the 5 rem per year guideline. Of these, 1860 exposures occurred in connection with tests in the Pacific, and 296 of the exposures resulted from NTS testing activities.

Below is a listing by year (and by test series where applicable) to show numbers of exposures in excess of the exposure guideline of 5 rem.

1946	(Trinity Site)	1
1946	Crossroads	14
1948	(Pacific) Sandstone	7
1951	Ranger (NTS)	3
1951	Greenhouse	307
1952	Tumbler-Snapper (NTS)	9
1952	Ivy	18
1953	Upshot-Knothole (NTS)	61
1954	Castle	1,049
1955	Teapot (NTS)	24
1956	Flintlock	4
1956	Redwing	378
1957	Plumbbob (NTS)	34
1958	Hardtack (NTS)	7
1958	Hardtack	87
1961	Nougat (NTS)	107
1962	Nougat (NTS)	14
1963	(NTS) Dominic	9
1964	(NTS) Whetstone	2
1965	(NTS) Whetstone	21
TOTAL	....	2,156

Topic A-10

Q. Clear up the record about health effects on the Marshallese as regards such injuries as thyroid, etc.

A. A report entitled "A Twenty-Year Review of Medical Findings in a Marshallese Population Accidentally Exposed to Radioactive Fallout" by R. A. Conard, et al (BNL-50424) has been previously provided to the Subcommittee staff. The report describes the medical activities and the findings in the study population for the period 1954-1974. As of this date, a total of four cases of thyroid cancer among Rongelapese and three cases among Utirikese have been observed in a population of 243 exposed individuals. All cancers have occurred in females.

One inhabitant of the Marshall Island exposed to fallout died from a myeloid leukemia. Since completion of that report no additional cases of leukemia were found. Quite clearly the occurrence of one case might be due to chance rather than irradiation. No excess incidence of other forms of cancer has been observed.

Since 1974, a resident DOE physician visits Rongelap and Utirik approximately every three months. An exception to this was during 1977 when the people of Utirik indicated the DOE physician was not welcome. Recently, however, they invited the medical team to resume their surveillance.

Once a year, in addition to these quarterly visits, a larger medical team consisting of various specialists (endocrinologist, gynecologist, hematologist, pediatrician, etc.) goes to these islands to do physical exams of exposed and unexposed populations on Rongelap and Utirik.

The observation of three cases of thyroid cancer among the Utirikese cannot be explained. Compared to the Rongelapese, the estimated exposure of the people of Utirik was ten times as low. Also, the incidence of benign nodules in the people of Utirik is very low. As expected, the incidence of benign nodules in the Rongelap is high. Interpretation of these results is complicated by the fact that the natural incidence of these abnormalities in the Marshallese is unknown.

An effort will be made in 1978 to reassess dose estimates for the Utirikese.

Mr. ROGERS. Our next witness will be from the Veterans Administration. We have, it is my understanding, Dr. Paul A. Haber, Assistant Chief Medical Director for Professional Services, the Veterans Administration; accompanied by Dr. James J. Smith, Director of Nuclear Medicine Service, Department of Medicine and Surgery; Sidney J. Shuman, Chairman of the Board of Veterans Appeals; J. C. Peckarsky, Director, Compensation and Pension Service, Department of Veterans Benefits; and Dr. William C. Moloney, director of the hematology division, Peter Bent Brigham Hospital, consultant to the Veterans Administration.

We welcome you gentlemen to the committee and appreciate your patience. Considering the time and that you are hungry, we will try not to prolong this more than is necessary. Your statement will be made a part of the record in full, and you may proceed as you desire.

It might be well for you, Dr. Haber, to identify your colleagues for the reporter and for the committee.

STATEMENTS OF PAUL A. HABER, M.D., ASSISTANT CHIEF MEDICAL DIRECTOR FOR PROFESSIONAL SERVICES, DEPARTMENT OF MEDICINE AND SURGERY, VETERANS ADMINISTRATION, ACCOMPANIED BY SIDNEY SHUMAN, CHAIRMAN, BOARD OF VETERANS APPEALS; J. C. PECKARSKY, DIRECTOR, COMPENSATION AND PENSION SERVICE, DEPARTMENT OF VETERANS BENEFITS; JAMES J. SMITH, M.D., DIRECTOR OF NUCLEAR MEDICINE SERVICE, DEPARTMENT OF MEDICINE AND SURGERY, AND WILLIAM C. MOLONEY, M.D., DIRECTOR, HEMATOLOGY DIVISION, PETER BENT BRIGHAM HOSPITAL (MASS.), CONSULTANT TO THE VETERANS ADMINISTRATION

Dr. HABER. Thank you, Mr. Chairman.

Mr. Chairman and other distinguished members of the subcommittee, my colleagues and I are pleased to appear before you today, to discuss matters of great mutual concern.

I am Dr. Paul Haber, Assistant Chief Medical Director for Professional Services for the Department of Medicine and Surgery of the Veterans Administration. I would wish to introduce briefly each of the gentlemen from the Veterans Administration who accompany me.

To my left is Dr. James J. Smith, Director of Nuclear Medicine Service, Department of Medicine and Surgery, who will be able to respond to your questions respecting radiation and nuclear medicine concerns.

Mr. Sidney J. Shuman, Chairman of the Board of Veterans Appeals, who will be able to respond on the appeals process on compensation claims, and who has compiled data respecting the number of appeals cases which have come under his jurisdiction.

Mr. J. C. Peckarsky, Director of Compensation and Pension Service, who has also compiled data respecting the number of claims that have been filed for compensation and pension with the Veterans Administration.

Also with us this morning is Dr. William C. Moloney, director of the hematology division of the Peter Bent Brigham Hospital in Boston, Mass. Dr. Moloney, who is also a professor emeritus at

Harvard University, is a consultant to the Veterans Administration and has done a great deal of work in this area of radiation exposure dating back to the 'tests in the Marshall Islands and subsequent to that.

Mr. ROGERS.We welcome all of you gentlemen to the committee and appreciate your presence.

Dr. HABER. The Veterans Administration has long been actively involved in the study of the relationship between radiation exposure and resultant injury and disease. Two of our most important missions are to compensate veterans for disabilities incurred or aggravated as a result of their active military sevice, and to provide the best possible medical care for the treatment of these disabilities. We have therefore been placed, we believe, in a unique position to observe and study the important issues under consideration today, and I am hopeful it will be shown that we have responded by shouldering our responsibilities well.

It has become increasingly clear, both before and as a result of testimony brought out at his hearing, that many imponderables exist relating to the number of exposed persons, the extent of exposure, and the limits of safety in such exposures. My agency stands ready to cooperate fully in the obviously necessary, detailed, expeditious studies that clearly must be promptly pursued. I believe we have carried our mission in the Veterans Administration with compassion and equity in the light of apparent limitations of our technical knowledge as of this time.

Mr. ROGERS. May I interrupt you? Let me ask you, you have resolved the privacy problem in giving the records to CDC?

Dr. HABER. We stand ready to cooperate with the CDC to the fullest extent to pursue the issues.

Mr. ROGERS. So, there is no longer any reason why they cannot get all of the records?

Dr. HABER. No, sir. We have had communications with Dr. Caldwell in at least two different forms, and we look forward to cooperating with him.

Mr. ROGERS. What I am asking, they may now obtain all of the records that they request?

Dr. HABER. Yes.

Mr. ROGERS. Thank you.

Dr. HABER. While we are very much aware that the study of radiation-related diseases is a relatively new one and that many uncertainties remain, the Veterans Administration succeeded in keeping abreast of the latest scientific developments. Two of my associates here today, Dr. Smith on my left and Dr. Maloney, may be accurately described as recognized experts in this field.

At this time I would like to introduce Dr. James J. Smith to continue the testimony.

Mr. ROGERS. Very well. Dr. Smith?

STATEMENT OF JAMES J. SMITH, M.D.

Dr. SMITH. Thank you. My name is Dr. James J. Smith. I am Director of the Nuclear Medicine Service for the Veterans Administration, Washington, D.C.

In evaluating claims for service connection for radiation injury or disease, the Veterans Administration will recognize service connection for either the immediate or delayed direct results of ionizing radiation. We recognize, for example, that there is a well-established cause and effect relationship between direct exposure to radiation of sufficient intensity, and the development of certain forms of leukemia. This was proven most notably by the aftereffects on the nuclear bombs detonated over Hiroshima and Nagasaki.

Obviously, in determining whether a malignancy is or is not the result of exposure to radiation in any given case, the more that can be determined about the nature of the exposure and the disease process itself, the better. Our review of claims based on such exposure only follows detained development of the facts and circumstances surrounding the exposure peculiar to that claim. For example, it is most helpful to discover the distance of the individual from the center of an atomic blast, since it is known that beyond 2,500 meters from the blast—and possibly or probably 2,000 meters—irradiation effects seldom occur. Neutron effects, if such they were, do not occur much beyond 1,000 meters, The experience of the Japanese bombings has shown conclusively that the direct blast effect, and not fallout, causes leukemia when the individual is close enough to the epicenter to be affected.

When available, the film badge readings of exposed individuals or other indicators of radiation exposure amounts are also crucial in establishing medically a probable connection between radiation exposure and the development of certain forms of leukemia. It is known that these film badges detected gamma rays, and that neutrons do not travel at all as far as gamma rays. Although it cannot be said that there is a precise threshold below which radiation does not result in leukemia, or above which it always occurs, the prevailing opinion among experienced and competent hematologists is that an individual would need an exposure of 75 to 100 rad—that is 75,000 to 100,000 millirad—to become the victim of leukemia.

While every effort is made to determine the type, duration, and cumulative amount or radiation in each case, it has always been our policy that service connection may be established without regard to the length of time between such exposure and the known onset of the disease process if the disease is otherwise directly traceable to the effects of radiation during service. Of course, it is imperative that a discriminating and conclusive diagnosis of the disease be made, as leukemia and other malignancies are of many types, some of which have never been shown to result from radiation exposure.

The trained adjudication personnel to whom the Veterans Administration entrusts the responsibility of ruling on claims have access to the best medical advice available anywhere. Besides their having readily available the many medical specialists within our own agency, working agreements also exist with independent medical experts who are nationally known in the field of nuclear medicine and radiation biology, whose opinions are frequently solicited in individual cases. The Armed Forces Institute of Pathology provides, upon request, detailed histological analysis of available tissue samples. Those personnel whose duty it is to make the decision in individual claims are instructed to do so with compassion, and if any reasonable doubt is found to exist, it is by regulation (38 C.F.R. paragraph 3.102) always to be resolved in the veteran's favor.

By our information, there were some 174,000 veterans who participated in atomic tests since Project Crossroads in Bikini Atoll in 1946. Since December 1967, the regional offices of our agency received for rating 148 claims for injuries resulting from radiation exposure from all sources, of which just 34 were for disease claimed to have resulted from atomic bomb testing. Of these 34, 6 have been allowed; of the remainder, 13 had no diagnosis of disease, and the remaining 15 had such a diagnosis but were denied. A detailed compilation of these statistics is attached as an addendum—appendix I—to this statement [see p. 465].

The Board of Veterans Appeals, to which a veteran may file an appeal should his claim be denied by the agency of original jurisdiction, has been keeping statistics on radiation exposure-related appeals since the early 1970's. Of the 83 such claims decided on appeal, 51 involved alleged exposure to nuclear fallout; 38 of these cases involve the issue of service connection for cancer; 6—16 percent—were allowed, all involving leukemia, and 4 allowances were made on the basis of exposure to radiation. This 16-percent allowance rate compares favorably with the overall allowance rate on appeals of all kinds to the Board of Veterans Appeals. A detailed breakdown of statistical data compiled by the Board is also attached as an addendum to this prepared statement—appendix II [see p. 468].

We believe that this agency's conscientious efforts to fairly resolve the issues raised in these claims will bear public scrutiny well. In each case, every effort is made to reach a just conclusion within the limits of current scientific knowledge and the statutory authority vested in us by Congress.

Thank you, Mr. Chairman, for affording me and the agency I represent the opportunity to be heard. My associates and I will be more than pleased to entertain any questions you may have.

[Testimony resumes on p. 471.]

[Attachments to Dr. Haber's and Dr. James J. Smith's prepared statement follow:]

APPENDIX I

* THERE HAVE BEEN APPROXIMATELY 174,000 VETERANS ENGAGED IN ATOMIC TESTS SINCE PROJECT CROSSROADS ON BIKINI ATOLL IN 1946.

* CENTRAL OFFICE RECEIVES RATINGS OF CLAIMS FOR INJURIES FROM RADIATION EXPOSURE FROM ALL SOURCES.

* 148 RATINGS HAVE BEEN RECEIVED IN PAST 10 YEARS (SINCE DEC. 1967).

* THESE CASES REPRESENT DECISIONS OF ORIGINAL JURISDICTION PRIOR TO ANY APPELLATE REVIEW.

* OF THE 148 RATINGS, 34 WERE FOR DISEASE CLAIMED RESULTING FROM A-BOMB TESTING.

* OF THE 34 IN A-BOMB TESTS, 6 HAVE BEEN ALLOWED.

* OF THE 34 IN A-TESTS, 13 HAD NO DIAGNOSIS AND 15 WHICH HAD DIAGNOSIS WERE DENIED.

* 63 CLAIMS FOR DISEASE RESULTED FROM IRRADIATION AND OTHER EXPOSURE.

* OF THE 63, THERE WERE 22 CLAIMS ALLOWED AND 20 CLAIMS DENIED.

* OF THE 63, THERE WERE 21 CLAIMS WITH NO DIAGNOSIS.

* THERE WERE 51 CLAIMS WHERE NO SPECIFIC EXPOSURE WAS ALLEGED.

* OF THESE 51 CLAIMS, 35 CLAIMS HAD NO DIAGNOSIS AND 16 WERE DENIED.

* OF THE 148 CLAIMS, 16 WERE DIAGNOSED LEUKEMIA AS FOLLOWS:

  GRANULOCYTIC LEUKEMIA - 6
  HAIRY CELL LEUKEMIA - 2
  LYMPHOCYTIC LEUKEMIA - 3
  MYELOCYTIC LEUKEMIA - 2
  MYELOGENOUS LEUKEMIA - 2
  LEUKEMIA, UNSPECIFIED - 1

APPENDIX I-2

- OF THE 16 LEUKEMIA CLAIMS, 5 WERE DIAGNOSED IN VETERANS WHO CLAIMED PARTICIPATION IN A-TEST AND 11 FROM ALL OTHER CAUSES OF RADIATION EXPOSURE.

- OF THE 5 INVOLVED IN A-TESTS, 3 WERE ALLOWED AND 2 DENIED.

- IN 1 CASE DENIED, VETERAN CLAIMS HE WAS AT DESERT ROCK, NEVADA, IN 1951, BUT HIS PARTICIPATION COULD NOT BE CONFIRMED.

- THE OTHER IS THE DONALD E. COE CASE CURRENTLY UNDERGOING STUDY BY A SPECIALIST AT THE ARMED FORCES INSTITUTE OF OF PATHOLOGY.

RADIATION EXPOSURE CLAIMS

	Number	Percent
A. Total number of cases in study	148	100.0%
Cases with diagnosis	79	53.4%
Cases, no diagnosis	69	46.6%
B. Cases with diagnosis	79	100.0%
Allowed	28	35.4%
Denied	51	64.6%
C. Total cases in study	148	100.0%
Claimed A-test	34	23.0%
Claimed other exposure	63	42.6%
No exposure	51	34.4%
D. Those who claimed A-test	34	100.0%
Allowed	6	17.7%
Denied	15*	44.1%
No diagnosis	13	38.2%
E. Those who claimed other exposure	63	100.0%
Allowed	22	34.9%
Denied	20	31.8%
No diagnosis	21	33.3%
F. Those where no exposure alleged	51	100.0%
Allowed	0	0%
Denied	16	31.4%
No diagnosis	35	68.6%

* These 15 cases have diagnoses as follows:

Brain tumor - 2
Cancer of bladder - 2
Cancer of kidney - 1
Cancer of maxillary sinus - 1
Cancer of pancreas - 1
Degenerative joint disease - 1
Hairy cell leukemia - 2
Macular degeneration - 1
Myelogenous leukemia - 3
Myeloma, multiple - 1

APPENDIX I-3

IN SUMMARY

Total Cases	148	
Allowed	28	18.9%
Denied	51	34.5%
No diagnosis	69	46.6%
Alleged Exposure	97	65.5%
No Exposure Shown	51	34.5%

CASES DIAGNOSED "LEUKEMIA"

	Number	Percent
Cases diagnosed "Leukemia"	16	100.0%
Allowed	3	18.8%
Disallowed	13	81.2%
Claimed A-test exposure	5	31.3%
Claimed other exposure	11	68.7%
Claimed A-test exposure	5	100.0%
Allowed	3	60.0%
Disallowed	2	40.0%
Claimed other exposure	11	100.0%
Allowed	0	0%
Disallowed	11	100.0%

The leukemia cases were diagnosed as follows:

Granulocytic leukemia - 6
Hairy cell leukemia - 2
Lymphocytic leukemia - 3
Myelocytic leukemia - 2
Myelogenous leukemia - 2
Leukemia, unspecified - 1

APPENDIX II

- BVA HAS A RECORD OF 83 CLAIMS FOR SERVICE CONNECTION FOR DISEASES ALLEGEDLY DUE TO EXPOSURE TO RADIATION FROM VARIOUS SOURCES IN SERVICE.

- 51 CASES INVOLVED CLAIMED NUCLEAR FALLOUT EXPOSURE. EIGHT WERE ALLOWED BUT ONLY FOUR ON BASIS OF EXPOSURE.

- 38 OF THE 51 CASES INVOLVED CANCER. OF THE 38 CASES, 25 INVOLVED LEUKEMIA. SIX WERE ALLOWED, ALL INVOLVING LEUKEMIA, BUT ONLY FOUR ON BASIS OF EXPOSURE. THE REMAINDER OF THE 51 CASES INVOLVED MANY OTHER DISEASES (NONMALIGNANT).

- 14 CASES INVOLVED IRRADIATION BY X-RAYS. OF THE 14 CASES, 11 INVOLVED CANCER AND OF THESE SIX INVOLVED LEUKEMIA, WITH ONE ALLOWED.

- NINE CASES INVOLVED MICROWAVE IRRADIATION (RADAR). FOUR INVOLVED CANCER WITH ONE BEING LEUKEMIA AND IT WAS ALLOWED.

- SIX CASES INVOLVED HANDLING RADIOACTIVE EQUIPMENT. OF THESE THERE WERE THREE CANCER CASES ALL INVOLVING LEUKEMIA TWO OF WHICH WERE ALLOWED, BUT ONE FOR REASONS OTHER THAN EXPOSURE.

- ONE CASE INVOLVED DIRECT EXPOSURE TO RADIOACTIVE CHEMICALS. THE DISABILITY WAS NOT CANCER AND CLAIM WAS DENIED.

- ONE CASE INVOLVED EXCESSIVE EXPOSURE TO SUNLIGHT. THIS WAS A SKIN CANCER CASE AND WAS ALLOWED.

- ONE CASE INVOLVED ULTRAVIOLET AND INFRARED TREATMENT. DISEASE WAS NOT CANCER AND CLAIM WAS DENIED.

CASES DIAGNOSED LEUKEMIA

	Number	Percent
Cases diagnosed as leukemia	35	100%
Allowed	10	29%
Denied	25	71%
Claimed A-test exposure	25	71%
Claimed other exposure	10	29%
Claimed A-test exposure	25	100%
Allowed	6	24%
Denied	19	76%
Claimed other exposure	10	100%
Allowed	4	40%
Denied	6	60%

APPENDIX II-2

The leukemia cases were diagnosed as follows:

myelogenous - 4
lymphatic - 5
myeloblastic - 2
lymphocytic - 3
granulocytic - 1
myeloid - 1
reticuloendotheliosis - 1
myelomonocytic - 2
myelocytic - 4
monocytic - 1
unspecified - 1

RADIATION EXPOSURE CLAIMS

	Number	Percent
A. Total number of cases in study	83	100%
Cases held disability unrelated to exposure	56	68%
Cases held no significant exposure or none	59	71%
B. Total cases in study	83	100%
Claimed nuclear fallout exposure	51	61%
Claimed X-ray treatment	14	17%
Claimed microwave exposure (radar)	9	11%
Claimed handled radioactive equipment	6	7%
Claimed direct exposure to radioactive chemical	1	> 1%
Claimed exposure to excessive sunlight	1	> 1%
Claimed ultraviolet and infrared treatment	1	> 1%
C. Those who claimed nuclear fallout exposure	51	100%
Allowed	*8	14%
Denied	43	86%
(* four on basis of exposure)		
Outside medical opinion sought	15	39%
Cancer cases	38	75%
D. Cancer cases with fallout exposure claimed	38	100%
Allowed	*6	16%
(*four basis of exposure)		
Denied	32	84%
Outside medical opinion sought	15	39%
Leukemia cases	25	66%
E. Leukemia cases with fallout exposure claimed	25	100%
Allowed	*6	24%
(*four on basis of exposure)		
Denied	19	76%
Outside medical opinion sought	13	52%
F. Those who claimed X-ray treatment	14	100%
Allowed	*2	14%
(*one on basis of exposure)		
Denied	12	86%
Outside medical opinion sought	8	57%
Cancer cases	11	79%

APPENDIX II-3

	Number	Percent
G. Cancer cases with X-ray treatment claimed	11	79%
Allowed	1	9%
Denied	10	91%
Outside medical opinion sought	8	73%
Leukemia cases	6	55%
H. Leukemia cases with X-ray treatment	6	100%
Allowed	1	17%
Denied	5	83%
Outside medical opinion sought	3	50%
I. Those who claimed microwave exposure (radar)	9	100%
Allowed	1	11%
Denied	8	89%
Outside medical opinion sought	4	44%
Cancer cases	4	44%
J. Cancer cases with microwave exposure (radar)	4	100%
Allowed	1	25%
Denied	3	75%
Outside medical opinion sought	2	50%
Leukemia cases	1	25%
K. Leukemia cases with microwave exposure (radar)	1	100%
Allowed	1	100%
Denied	0	0%
Outside medical opinion sought	1	100%
L. Those who claimed handled radioactive equipment	6	100%
Allowed (*one on basis of exposure)	*2	33%
Denied	4	67%
Outside medical opinion sought	3	50%
Cancer cases (all leukemia)	3	50%
M. Leukemia with handling radioactive equipment	3	100%
Allowed (*one on basis of exposure)	*2	67%
Denied	1	33%
Outside medical opinion sought	3	100%
N. Those claiming direct exposure, excessive sunlight exposure or ultraviolet and infrared treatment	3	100%
Allowed	1	33%
Denied	2	67%
Outside medical opinion sought	1	33%
Cancer case	0	0%

Mr. **Rogers**. Thank you very much.

Dr. **Haber**. I would at this time like to introduce Dr. William C. Moloney, professor emeritus at the Harvard Medical School, and director of the hematology division of the Peter Bent Brigham Hospital of Boston, Mass. He has a short statement he would like to read. He will be available for questions on the hematologic aspects of this problem, sir.

Mr. **Rogers**. Certainly. Dr. Moloney?

STATEMENT OF WILLIAM C. MOLONEY, M.D.

Dr. **Moloney**. I have submitted the written statement, and could perhaps even abbreviate it [see p. 473].

I am a private physician and I am not associated with any government or other agency, except in this instance—my first—as a consultant to the Veterans' Administration.

I would like to address this problem as a physician trained in hematology and practicing it for 40 years, with a special interest in leukemia. I have had a rather unusual interest in leukemia from the standpoint of radiation exposure, and in 1952 went to Hiroshima and stayed there for 2 years as a member of the Atomic Bomb Casualty Commission, its Director of Research. Following this, I came back to the United States and was made a member of the Shields-Warren Committee on the Long-term Effects of Ionizing Radiation on the Blood and Blood-forming Organs, of which Dr. Cronkite was the vice chairman.

Subsequently, in 1960 and 1961, I went to the Marshall Islands and visited Rongelap, and remained there, studying those natives as a member of the field team. I also visited Utirik, which is about 115 miles to the west of Rongelap, and remained there to study the Utirik natives.

I was particularly interested, of course, in not only the physical examinations, but I engaged in bone marrow studies, cytogenetic studies, that is the chromosones of some of the people exposed. I have also had considerable experience as a consultant to large-scale studies, one of which was under the auspices of WHO, the World Health Organization, on about 80,000 women exposed in many large cities throughout the world to radiation of the pelvis from radium and X-rays; and another very large study, nearly 100,000 people who were given relatively low levels in diagnostic procedures.

I am also very well aware what has been happening in more recent Japanese reports from my original contacts with the atomic bomb survivors.

I am particularly anxious to furnish this committee some of my views on the hematologic aspects which have not been really, I believe, brought out here. In the first place I would like to point out that the establishment of a diagnosis of leukemia has to be an exact one. There are certain forms of leukemia which have never been known to be attributable to radiation exposure—that is a definite fact, chronic lymphatic for one, lymphoma, lymphysarcoma, which have been mentioned as radiation induced, have never been identified in any large series, or in my own personal experience——

Mr. CARTER. Excuse me, sir. I would like for you to repeat that, I did not understand.

Dr. MOLONEY. I said specifically that certain forms of leukemia are known to be attributable to high doses of radiation, that is an unequivocal fact. But certain other forms of leukemia, hairy cell leukemia for one, and all forms of lymphosarcoma which become leukemic, have never been established as a result of any amount of exposure to radiation, of a civilian in Hiroshima or anywhere else.

Mr. CARTER. How long have we known of hairy cell leukemia?

Dr. MOLONEY. I beg your pardon?

Mr. CARTER. How long have we known of hairy cell leukemia?

Dr. MOLONEY. I published a paper that is coming out in the next issue of the American Journal of Medical Sciences; there are 22 cases that we have observed in the Peter Bent Brigham Hospital during the last 4 or 5 years. This disease had not even been identified up until about 8 years ago, or 10 years ago.

Mr. CARTER. About how long ago?

Dr. MOLONEY. About 8 or 10 years ago.

Mr. CARTER. I believe you are wrong. In 1958 it was first identified as a separte entity.

Dr. MOLONEY. I will not quibble with it.

Mr. CARTER. You need not quibble because that is correct. I am sure you know Dr. Beck, an associate of yours at Harvard.

Dr. MOLONEY. Yes.

Mr. CARTER. All right, thank you.

Dr. MOLONEY. I just want to establish a few hematologic facts which I think are very important. I am very impressed, having listened to the testimony before this committee, that the possibility has arisen that lower levels of radiation than most of us have thought to be leukemogenic, may well be. I think it is of extreme importance that this committee has brought out this, and all the agencies involved should benefit, not only the veterans but the American public at large, and the scientific community, to establish unequivocally by the most fixed standards of radiation biology and good hematologic standards whether this is actually the fact.

Thank you.

[Dr. Moloney's prepared statement follows:]

STATEMENT OF WILLIAM CURRY MOLONEY, M.D.

Statement on Leukemogenic Effects of Ionizing Radiation

William Curry Moloney,M.D.
Professor of Medicine Emeritus
Harvard Medical School
Director, Emeritus, Hematology Division,
Peter Bent Brigham Hospital
Boston, Massachusetts

The following opinions are based on my forty years experience as a specialist in hematology with a particular interest in leukemia. During my career, I have taken care of hundreds of patients with leukemia and have carried out and published clinical, laboratory and experimental studies on this disease.

For the past 24 years, I have been especially concerned with investigations on the cause and mechanisms of development of leukemia. In March, 1952 I went to Japan and served for two years, as Deputy Director in charge of Research for the Atomic Bomb Casualty Commission, During this period I was author or co-author of five papers which recorded observations on leukemia occurring in atomic bomb survivors.

Subsequently, I continued my interest in radiation-induced leukemia. In 1957 I was made a member of the National Academy of Sciences Sub-Committee on the Effects of Ionizing Radiation on the Blood Forming Organs. As a result of this

Committee's investigations on all sources of radiation exposure, a formal report was submitted to the government. Essential conclusions of these studies were also published in an article entitled "Radiation Leukemogenesis: An Analysis of the Problem" by Cronkite, Moloney and Bond in the American Journal of Medicine, Volume 28, Pages 673 to 682, 1960.

I also participated as hematology consultant to Brookhaven National Laboratory in field trips to the Marshall Islands in 1960 and 1961. During these expeditions I participated in examinations of Marshallese exposed to fallout from the hydrogen bomb detonated on March 1, 1954. In particular, I carried out cytogenic and morphologic studies on the bone marrow of Marshallese natives. I have also served as hematology consultant on large scale surveys of patients who were treated with radium and x-ray for pelvic cancer under the auspices of the World Health Organization and on a survey of American patients who were given low level doses of I131 radiation for diagnostic purposes.

During the past twenty years and continuing to the present I have engaged in experimental studies on non-inbred and inbred rats, in an attempt to discover the mechanisms of leukemia induction by total body radiation alone and in combination with chemical agents. A number of publications have resulted from these research studies.

From my extensive personal experience with over 1000 cases of leukemia and with the knowledge of the findings of the atomic bomb survivors along with the results of a number of surveys carried out in patients exposed to diagnostic and therapeutic radiation, it is my opinion that acute and chronic myelogenus leukemia may be induced in some individuals exposed to high levels of total body radiation. Leukemia may also be induced by therapeutic radiation in high and repeated dosage administered to extensive areas of bone marrow. I firmly believe that there is no scientific evidence that low levels of ionizing radiation are leukemogenic in man.

Dr. HABER. Mr. Chairman, may I make a statement?

Mr. ROGERS. Certainly.

Dr. HABER. I would like to indicate to you that the Veterans' Administration takes this matter very seriously, are encouraged by the testimony delivered at these hearings—we have been in attendance the last few days—have reenforced our resolve to be as helpful as we can.

I would like to outline to you very briefly what we propose to do.

Mr. ROGERS. Thank you, that would be helpful, doctor.

Dr. HABER. In the first place, we will of course cooperate with the Department of Defense, the Department of Energy, the HEW, in the researches that they propose; we will exchange data with them.

Second, we are a member of the National Council of Radiation Protection, which deals with other forms of radiation under the Environmental Protection Agency, trying to establish maximum safe doses for other kinds of radiation, particularly diagnostic X-radiation.

Third, my office is preparing a professional services letter designed to alert all physicians in the Veterans' Administration as to the proper procedure to be used in the diagnosis of early leukemia, or a preleukemic phase, for patients who apply to us, who may have been exposed to one of these test shots; and to try to solicit that information even before it is forthcoming from the veteran applicant.

And finally, we will establish a task force within the agency. Individuals have been identified, and by my rough calculation talking with other heads of the agency, some 20 individuals have been working on this in some measure. This will be established into a task force where responsibility can be assigned.

Mr. CARTER. Mr. Chairman?

Mr. ROGERS. Yes, Dr. Carter?

Mr. CARTER. Might I make a statement here?

Mr. **Rogers**. Certainly.

Mr. **Carter**. Dr. William Beck provided the latest edition of the textbook "Hematology," just published a couple of months ago by McGraw Hill. Dr. Beck, as I understand it, Dr. Moloney, is the head of the Hematology Research Laboratory at Harvard Medical School.

Dr. **Moloney**. I was one of the coauthors.

Mr. **Carter**. In talking with Dr. Costan W. Berard at the NCI, who said he wrote a chapter in "Hematology," he indicated to my staff that about 2 percent of all leukemias are hairy cell and that he knows of no studies having been done of irradiation and hairy cell leukemia—no studies. Therefore I submit, no one could make a statement that this was caused or not caused by radiation. No studies have been made that would justify such a statement.

Thank you, Mr. Chairman.

Dr. **Moloney**. Can I answer that?

Mr. **Carter**. Yes, sir, and I would like to ask you one question, if I might. May I, Mr. Chairman?

Mr. **Rogers**. Certainly.

Mr. **Carter**. How much were you paid for coming down here, please, sir?

Dr. **Moloney**. I have not looked at the fee yet.

Mr. **Carter**. Yes, sir.

Dr. **Moloney**. Will you let me answer, please?

Mr. **Carter**. Yes, sir.

Dr. **Moloney**. What they told me—no amount of money could have gotten me down here; frankly, I came because I felt it was a public duty, first. Second, they gave me an overall fee which they said would cover my transportation, my stay which, incidentally, it has been very difficult for me to stay over.

Mr. **Carter**. Are you employed by the Veterans' Administration?

Dr. **Moloney**. I am getting a total fee, when this is all done, of maybe $100 to $150; it could be a little higher, I really do not know.

Mr. **Carter**. Yes, sir.

Dr. **Moloney**. It is a round sum, covering everything. I do not consider that a great deal of money for my expertise, first of all.

To answer your question about hairy cell, you said there was no information. Well, first of all, it is an extremely rare disease.

Mr. **Carter**. It is my understanding that about 2 percent of all leukemias are hairy cell.

Dr. **Moloney**. I am not interested in percent, I will tell you what my private knowledge is, and I cannot tell you anything else.

Mr. **Carter**. Yes, sir.

Dr. **Moloney**. In 600 cases of lymphosarcoma in the last 11 years at the Brigham we saw 22 cases. I would say the incidence is about 1 in 1 million. So, you are right, nobody has a lot of information. But none of those cases had any exposure radiation which would incriminate.

Second—and I think that is very important—it is either a "B" or "T" cell disease, which is not related to any myelogenus tissue; it is more related to the lymphatic tissue because none of these tissues have been shown could be leukemogenically turned on by radiation. Now, that is a fact.

Mr. **Carter**. Mr. Chairman, I would have to answer that by reading directly from "Hematology."

> Leukemic Reticuloendotheliosis (hairy cell leukemia) was first described as a distinct entity by Bouroncle, Wiseman and Doan in 1958. It is a rare but important disease that is often difficult to differentiate from chronic lymphocytic leukemia.

Now, Mr. Chairman, I submit that this man, although he may have been and probably is a great scientist at Peter Bent Brigham and Harvard, puts his trousers on just like anyone else. He said that this disease had not even been identified until 8 or 10 years ago when, in fact, it goes back to 1958, which is 22 years. I say he should have known this. I could not regard his testimony as being definitive in this area.

Thank you, Mr. Chairman.

Dr. **Moloney**. Could I answer that, please?

Mr. **Rogers**. Yes, sir. Surely.

Dr. **Moloney**. Well, if you read my article when it comes out, you will find out that we had recognized hairy cell leukemia within that period, and the disease has only been recognized as an entity, and you are now retrospectively going back; that is quite easy to do. A lot of people today do not recognize hairy cell, it is a difficult diagnosis.

But I think we now have markers which have recently been developed, geneologic markers, that clearly distinguish this as either a "B" or "T" cell—these were only available in the last 4 or 5 years.

Mr. **Carter**. Will you show me one study concerning irrradiation and hairy cell leukemia?

Dr. **Moloney**. I will tell you a number of studies of large populations in which no hairy cell has been described.

Mr. **Carter**. We are talking about studies of hairy cell leukemia and radiation.

Dr. **Moloney**. I have tried to explain that there are so few cases that the study has not been done. But the alternative, there are no studies on humans exposed to radiation where hairy cell leukemia has been identified as radiation-produced.

Mr. **Carter**. If there have been no studies made, then you cannot make the statement that there is no relationship between irradiation and hairy cell leukemia.

Dr. **Moloney**. I emphatically do. I emphatically want this on the record that I disagree completely.

Mr. **Carter**. Well, I have seen this done before. But what I say, is, if you have the studies concerning humans to justify your statement, let us have it.

Mr. **Rogers**. Let me now, if I may, get to some of the cases that have been handled by the VA. I think you said six claims have been allowed from blasts. Could you tell us which blasts they were, and when these claims were filed, and the names and the dates of those tests in which those people participated?

Dr. **Haber**. I would like to ask Mr. Peckarsky to answer that.

Mr. **Rogers**. Certainly. Mr. Peckarsky?

Mr. **Peckarsky**. I would have to, Mr. Chairman, furnish the exact identification for the record. The records that we used to compile this merely derived from an allegation that, "I was exposed to a blast," and we accepted that for putting him into this particular category. I think we can possibly identify some of the blasts that they alleged to have been exposed to, and we will be glad to furnish that to the committee.

Mr. ROGERS. You do not know any of those cases now?

Mr. PECKARSKY. No, sir; I do not have any individual cases with me today.

Mr. ROGERS. What were the exposure levels?

Mr. PECKARSKY. As far as badge readings? I do not have those.

Mr. ROGERS. How did you make your judgment? What evidence do you require?

Mr. PECKARSKY. We require an array of all available evidence. We do get from the Department of Defense the badge readings. We do examine the circumstances of service, the length of service, its duration. We round up all the evidence of the earliest manifestations of any symptomatology that can possibly be attributed, then we usually refer the entire claims record to our medical experts for an expression of opinion as to reasonable probability of relationship.

So, in order to answer your question definitively I would have to call in all of the individual claims folders that we made decisions on, and make them available to the committee.

Mr. ROGERS. Well, I presume the Board of Appeals has a rather consistent pattern of advisers; or do you?

Mr. PECKARSKY. I would have to ask Mr. Shuman to answer that.

Mr. ROGERS. I understand all of these had to be granted on appeal, none were granted——

Mr. SHUMAN. I do not believe that is right.

Mr. PECKARSKY. Four of these six were granted at the local level, and two on appeal.

Mr. ROGERS. I see.

Mr. SHUMAN. We granted six on appeal, Mr. Chairman. Those are a different group.

Mr. ROGERS. So, 12 have been granted?

Mr. SHUMAN. If our records are as complete as they should be, we know of 109 that we have records of. There may have been more, I really do not know. We did not start keeping records at the Board until we got involved with the AEC on a study they made in connection with occupational hazards in workers in radiation industries. That was back in the early 1970's, I believe, and we furnished them copies of our decisions entered in all radiation cases after we had taken out all the identifying factors.

Mr. ROGERS. Did you grant any of the claims from people that participated in the A tests?

Mr. SHUMAN. I can run through this and maybe I can give you that in a short time. I do have the six cases, or copies of the decisions, I do not have the cases, sir.

Mr. ROGERS. Well, can you tell us how many participated in the A tests?

Mr. SHUMAN. I would have to look at them one at a time, I do not have them cagegorized; but I do have them here.

One case involved a bomb test in June 1945.

Mr. ROGERS. Which test was that?

Mr. SHUMAN. This man was on duty at Kirkland Field, New Mexico in late June 1945.

Mr. ROGERS. That was at White Sands?

Mr. SHUMAN. It is not identified, sir. It says that he flew planes, exposed to radioactivity in cloud of first atomic explosion.

Mr. ROGERS. When did he file the claim?

Mr. SHUMAN. I do not have that, sir.

Mr. CARTER. Mr. Chairman, was that a member of the Tennessee National Guard?

Mr. SHUMAN. I really do not know, sir; I do not have that. I can tell you when he served, and I can tell you when he died, and I can tell you when we decided the case. That is all I have.

Mr. ROGERS. I understood from the Department of Energy records that the first test on an A bomb was in 1945. You said this was June?

Mr. SHUMAN. Sir, I said that is what is contended, I do not have the exact date of when the bomb was dropped. But this is the contention by the appellant which we accepted on face value.

Mr. ROGERS. You did not have any proof of when the test was?

Mr. SHUMAN. We have proof that he was there; yes, sir.

Mr. ROGERS. Well, where was he, and at what time?

Mr. SHUMAN. Officially, all I have sir—as I told you—is a brief of the case. The official record showed that the veteran was involved in some way in atomic bomb testing in New Mexico in the summer of 1945. That is as specific, sir, as I can be.

Mr. ROGERS. What are the other six?

Mr. SHUMAN. That is one of the six. Another one was involved in a thermonuclear test series May to June 1952, and I believe that was Eniwetok and Bikini. He also had been involved in the atomic test series at Indian Springs, Nev. in 1952-53.

Mr. ROGERS. And what was his exposure?

Mr. SHUMAN. 890 millirads. That was up to August of 1956.

Mr. ROGERS. Was that cumulative?

Mr. SHUMAN. That is a cumulative report that they furnished us; yes.

Mr. CARTER That is eight-tenths of a rad.

Mr. ROGERS. Eight-tenths of a rad, but you granted his claim.

Mr. SHUMAN. Yes; we granted the claim.

Mr. ROGERS. What was the claim for?

Mr. SHUMAN. Unfortunately, sir, he died of leukemia.

Mr. ROGERS. From leukemia. And what was the basis of granting that?

Mr. SHUMAN. If I can read it. Apart from a determination of whether the veteran did or did not receive an overexposure of radiation, it is the opinion of the Board that the evidence is so evenly balanced in this particular case as to raise a substantial doubt, as distinguished from mere speculation as to whether the disease causing the veteran's death result from radiation exposure during war-time service. Under the cited regulation—which is the one that was referred on in the prepared testimony about resolving reasonable doubt--that doubt was resolved in favor of the veteran. Of vourse, there is more to the case, with testimony that was taken.

Mr. ROGERS. Sure.

Mr. SHUMAN. I believe his widow appeared and we had the benefit of her testimony.

Mr. ROGERS. Yes; I understand. Dr. Moloney, would you have agreed with that.

Dr. MOLONEY. Absolutely.

Mr. ROGERS. Even though the exposure was only, what?

Dr. MOLONEY. I do not know what the exposure was.

Mr. ROGERS. He just told you.

Dr. MOLONEY. I do not think he gave me rads, or rems.

Mr. ROGERS. What was it?

Mr. SHUMAN. 0.89 rads.

Dr. MOLONEY. I would say under these circumstances a compassionate act, if I had sat on the Board, I would have bought it, absolutely. But on a scientific basis I do not agree that these levels of radiation have shown evidence to cause leukemia in the Japanese or any large-scale studies that I am personally aware of. That is my standard.

Mr. SHUMAN. I might say, Mr. Chairman, it is a little dangerous to decide these cases the way you and I are speaking about them here because there were other factors. In this particular case the man complained of a loss of energy after service, immediately after service. You of course know there is a presumptive period within 1 year after discharge that we can grant service connection for leukemia.

Mr. ROGERS. Yes.

Mr. SHUMAN. This man did have some loss of energy; he was described as being stooped; he had some yellowing around the eyes, as a lay witness testified.

Mr. ROGERS. All right, if we could go to the next.

Mr. SHUMAN. The next one was Trinity, I do have the test.

Mr. ROGERS. Trinity?

Mr. SHUMAN. Yes, sir. This man, according to the AEC report, had 2,000 millirads.

Mr. CARTER. 2,000 millirads, which means two rads.

Mr. SHUMAN. Yes, sir, I am reading these as I come to them.

Mr. ROGERS. What was his claim for?

Mr. SHUMAN. Leukemia, again.

Mr. ROGERS. Was it a death?

Mr. SHUMAN. No, sir, this was a live case.

Mr. ROGERS. And when did that show up after the test, when was the claim filed?

Mr. SHUMAN. It was diagnosed in 1967, sir; and he was discharged in November 1945.

Mr. ROGERS. So, it was not diagnosed until 1967?

Mr. SHUMAN. Until 1967.

Mr. ROGERS. Now, when did he first have evidence of leukemia?

Mr. SHUMAN. This is a particular case, and it is a peculiar case. The man may have had more exposure than AEC reported. This man was a security officer and was a chauffeur for General Groves during the Trinity tests.

Mr. ROGERS. Twenty-two years difference. But why would he not have a proper recording?

Mr. SHUMAN. There is some testimony in here that he actually was in a position to handle, actually—so they testified—some uranium that was not shielded. He had the opportunity to be in areas that other people did not.

Mr. ROGERS. The chauffeur was handling the uranium?

Mr. SHUMAN. Well, sir, that chauffeur business, I guess, came about, he was really a security man, and that was just one of his extra added duties.

Mr. ROGERS. And he had how many rems?

Mr. SHUMAN. The record shows 2,000 millirads.

Mr. ROGERS. Dr. Moloney, that would be about 2 rad?

Dr. MOLONEY. Two rad.

Mr. ROGERS. Do you agree with this finding?

Dr. MOLONEY. Yes; I agree because we are not sure that was the minimum amount. So, we assume it was the minimum amount. I would give him the benefit of the doubt that he might have gotten more.

Mr. CARTER. After 22 years, now, in this case. What type of leukemia was this, if you please?

Mr. SHUMAN. This man had acute granulocytic leukemia.

Mr. CARTER. And it was diagnosed when?

Mr. SHUMAN. In 1967.

Mr. CARTER. Again, 22 years, after he was exposed in 1945.

Mr. SHUMAN. That is right, sir.

Mr. CARTER. All right, sir.

Mr. SHUMAN. There well may be some other factors in this case.

Mr. ROGERS. All right, the next?

Mr. SHUMAN. This case involves a death case. This man was a supply officer handling supplies in the nuclear field. He was in nucleonics, as a matter of fact. I do not believe he was in a bomb test because I do not have that. You would compare him with a worker.

Mr. ROGERS. Perhaps X-ray, or something else.

Mr. SHUMAN. He was a supply officer, sir.

Mr. ROGERS. And what was his exposure?

Mr. SHUMAN. Now, this man had actually changes in the blood during his active duty period, so it made it rather easier to allow this case. He had some changes in his lymphocytes that we held were significant, and accordingly allowed the claim.

Mr. CARTER. What was his diagnosis?

Mr. SHUMAN. He died of acute monocytic leukemia.

Mr. CARTER. Yes, sir, that is correct. And his last exposure——

Mr. SHUMAN. Do you have that case up there, Doctor?

Mr. CARTER. Yes; I do. I find it very advantageous to keep informed.

Mr. SHUMAN. That is what we are trying to do, sir; and I am glad you have them.

Mr. CARTER. Now, this man was exposed in 1953, was he not?

Mr. SHUMAN. I cannot answer that off the top of my head, I have to look at it.

Mr. CARTER. I have the case, that is when it was.

Mr. SHUMAN. All right.

Mr. CARTER. He died in 1963, and you made your judgment in 1966.

Mr. SHUMAN. Yes, sir, that is right.

Mr. CARTER. How did you do this 3 years after the death, how did you make this?

Mr. SHUMAN. Based on the medical records that we had, Doctor; we may have even gone out for an independent—yes, we did, as a matter of fact, we went to the Armed Forces Institute of Pathology on this case. I do not know that that had anything to do with our decision.

Mr. CARTER. What abnormalities did he have in his blood count?

Mr. SHUMAN. I believe this one was based on——

Mr. CARTER. I want to ask you another question right now. How long, with modern treatment, does a person with acute monocytic leukemia last, back at that time in 1963? I will ask anyone that.

Dr. HABER. A matter of months.

Mr. CARTER. A matter of months. Three months at most, is that not correct, with an acute case without treatment, back before we had modern treatment?

Dr. HABER. Yes.

Mr. CARTER. All right, sir. He had acute monocytic leukemia and could not have lived with it for more than 3 months. This disease could not have existed back in 1953, according to your own witness here.

Mr. SHUMAN. He is not my witness, sir.

Mr. CARTER. You have heard him.

Mr. SHUMAN. He is an expert in his field, he is not my witness.

Mr. CARTER. There you go, and you want to deny these other people, but you have granted service-connection in this case where the veteran could not have had leukemia during the 1-year presumptive period.

Dr. MOLONEY. May I make a statement?

Mr. CARTER. Sure.

Dr. MOLONEY. I have followed a lot of patients with acute leukemia who have had preleukemic states for a number of years, with blood changes, and then they become acutely leukemic. As you have pointed out, up to 8 or 10 years ago, without our modern therapy, they usually died within 3 or 6 months. That is true.

But there can be preleukemic states, with evidence in the blood, and it amounts to years before the patient develops leukemia; that is well established.

Mr. CARTER. I expect you would make a good witness for the defense. But I do not agree.

Dr. HABER. May I add a statement? In this preleukemic stage, I believe we can do some good because I think we can, with the help of expert consultants, direct our position to be aware of that, so that we can get on top of the disease as quickly as possible.

Mr. CARTER. This is one of those cases, Mr. Chairman. Thank you, sir.

On the other hand, we have another case, and I would like to bring that up. Another man who has developed leukemia, and that was last year, 20 years after he was at Smoky. At the time of Smoky, or previous to that he was exposed to six or eight shots in Nevada. He was on sick call. He had nose bleeds, which is one of the symptoms of radiation sickness. And yet, after 20 years you are denying his claim. Why are you doing it?

Mr. SHUMAN. I am sorry, sir, I do not know the case you are talking about.

Mr. CARTER. That is the case of Donald Coe.

Mr. **Shuman**. I have not denied his case, sir.

Mr. **Carter**. His case has been denied, though.

Mr. **Shuman**. Not in my office, sir. It is on appeal to my office now.

Mr. **Carter**. It has been in your office previously, though, before it went back to Louisville and was denied.

Mr. **Shuman**. We have never entered a decision, Mr. Carter, in that case.

Mr. **Carter**. Oh, yes; the Louisville office made the decision, but Washington remanded it to Louisville and the decision was made on the basis of that recommendation.

Mr. **Shuman**. Yes, sir, but the final appellate decision is made by the Board of Veterans' Appeals, Mr. Carter, and we have not answered that case.

Mr. **Carter**. Fine, I hope you will make one. I hope you make a favorable one.

Mr. **Shuman**. We do what we can with the evidence.

I would like to ask a question, I do not believe we are on trial here. I believe you said "the defense." I am just wondering, are we on trial here, Mr. Chairman?

Mr. **Rogers**. Well, of course, obviously you are not on trial.

Mr. **Shuman**. Thank you.

Mr. **Rogers**. But I must say that people do get upset when certain things are developing that seem strange.

Mr. **Carter**. And unusual, I might add.

Mr. **Rogers**. So, I think the committee is trying to make some judgment as to what should be done in this overall problem of radiation, where we still have some experts not willing to admit that leukemia comes about from low-level radiation, although you have approved some cases.

Mr. **Shuman**. Yes, sir. I think that is the way we look at each individual case.

Mr. **Rogers**. I understand that. What we are trying to do now is lay some foundations, to see what actions the committee needs to take.

Mr. **Shuman**. We are anxious to find out the results of the committee's efforts, too, believe me; we need that expertise.

Mr. **Rogers**. Now, would you let us have the rest of the cases you were telling us about?

Mr. **Shuman**. I have lost count.

Mr. **Rogers**. I think it was four, was it not?

Mr. **Shuman**. Yes. I have two more. This man had active service from September 1944 to October 1945, October 1946 to June 1952, September 1954 to September 1966. He was at the Christmas Island and Johnston Island tests. It was reported that he had not more than the natural background, very limited exposure, 0.22 mrem.

This case was allowed, I believe—this one, sir, was not allowed on the basis of exposure at all, this was prostate cancer, which we felt took a long period of time to develop; and in view of his long period of service——

Mr. **Rogers**. It was not an exposure?

Mr. **Shuman**. We did not feel this to be due to atomic radiation, it happened to be in there because he claimed radiation.

Mr. **Carter**. Mr. Chairman? Did you say he served until 1966?

Mr. SHUMAN. His last period of service ended September 1966.

Mr. CARTER. And when did he develop leukemia?

Mr. SHUMAN. He did not have leukemia, to my knowledge, sir; he died of carcinoma of the prostate.

Mr. CARTER. Thank you.

Mr. ROGERS. All right, and the last one?

Mr. SHUMAN. The last one is the case that Mr. Carter, I think alluded to—no, I am sorry, he did not.

This is a case that we found some subleukemic findings in service, and based it on that. This is a well-known case.

Mr. CARTER. Paul Cooper's case?

Mr. SHUMAN. Yes, sir.

Mr. CARTER. What were the subleukemic findings?

Mr. SHUMAN. He had medical records showing recurrent sore throat, leg cramps, skin lesions, back pains, joint aches so severe as to require a physical profile precluding airborne activities.

Mr. CARTER. What date was that, please, sir?

Mr. SHUMAN. That was in the mid 1960's, Doctor. In April 1968 he complained of nausea, vomiting for the past 3 days. Later in the month he complained of cough, malaise, hoarseness, headache. He had some small hemorrhages, or signs of small hemorrhages in the palate and his liver was enlarged. He had considerable findings, also he had changes in the lymphocytes and our Board when it decided that case felt that was sufficient.

Mr. CARTER. When did he retire?

Mr. SHUMAN. When did he retire? October 1972, it says here.

Mr. CARTER. Was he granted compensation at that time, or retirement disability, permanent and total?

Mr. SHUMAN. Mr. Carter, I can only tell you what he did.

Mr. CARTER. When was he granted compensation, then?

Mr. SHUMAN. I do not know. We had the case in April 1977; that was one of the first appeals.

Mr. CARTER. That is one case I think certainly was deserved, one of them anyhow.

Mr. SHUMAN. That is the sixth, I believe.

Mr. ROGERS. I think it would be helpful if you could furnish to us the names of the claimants who filed claims as a result of radiation, separating them from the actual blasts and other forms of radiation; the level of radiation; the time of filing of claim; and the disposition. We would like to have the numbers of how many radiation claims have been filed in total, do we have that, the total number, or just those that have been granted?

Mr. SHUMAN. We can probably put this together.

Mr. ROGERS. I think it would be helpful for the committee.

Mr. SHUMAN. We can put it together, but I would like for the record's sake to have your questions presented to me in written form because my shorthand is not that great.

Mr. ROGERS. The record will have that. And we may have additional questions that we will submit in writing.

Mr. SHUMAN. We will be happy to do whatever we can, Mr. Chairman.

Mr. ROGERS. Now, I notice on page 2 of the statement you say that irradiation effects seldom occur beyond 2,500 meters. Now, has this been established by research of the VA, or how was this determined?

Dr. SMITH. Mr. Chairman, that figure was derived from information gained from people who had been present at the studies on the effects of radiation in Hiroshima and Nagasaki, and the Marshall Islands. As you know, there were figures for 1,000 meters, 1,500 meters, 2,000, 2,500, and so on up. This is a figure that we have obtained from those people.

Now, they do occur, but the frequency is much reduced after 2,500 meters.

Mr. ROGERS. And then I think you said also that you used as a rule that an individual would need an exposure of 75 to 100 rad to become the victim of leukemia.

Dr. SMITH. Well, there again, Mr. Chairman, that is a figure that one derives from the literature. My own feeling in this matter, particularly as a physician in the Veterans' Administration, looking at claims or appeals, I would not, I certainly would not insist that this kind of exposure be present at all. I would say any significant exposure would dispose me to render the medical opinion that leukemia, or some other oncological effect could have occurred.

Mr. CARTER. Mr. Chairman, if the gentleman would yield on this.

Mr. ROGERS. Certainly.

Mr. CARTER. We have a statement from you that 75 to 100 rads is the causation level for leukemia; is that correct?

Dr. SMITH. Oh, no, Dr. Carter, we both know that there is no threshold. In fact, in my statement you will read that nobody knows of a level above which leukemia always occurs, and below which it never occurs. We simply do not know of such levels.

Mr. CARTER. "Although it cannot be said that there is a threshold below which radiation does not result in leukemia, or above which it always occurs, the prevailing opinion among experienced and competent hematologists is that an individual would need exposure of 75 to 100 rads to become the victim of leukemia." You said that, sir; I did not say it.

Dr. SMITH. Yes; I said it, Doctor.

Mr. CARTER. Now, in one of the cases here we have 890 mrem, or 0.89 rads, where we have given service connection for leukemia, I believe after a period of 22 years, for what is less than even 1 rad.

Dr. SMITH. Right.

Mr. CARTER. And it is about 1/75 of the exciting dose which you mentioned.

Dr. SMITH. I would like to reiterate, Doctor, this is a figure that appears in the scientific literature. But in evaluating these patients from the point of view of humanity and trying to get in the total medical picture, I personally would not hold to this at all. I would be far below this.

Mr. CARTER. Well, suppose, if the Chairman would not mind, assuming that you are familiar with the case of Donald Coe, in which he was at Smoky and was taken to the site shortly after the explosion. There is no doubt that his badge showed exposure of 300 mrem, something in this area. There is also no doubt but that he likely ingested a rather large amount of radiation because of the dust there, radiation from alpha, beta, and gamma rays in the dust.

Now, at that same time as his exposure he was treated for what I maintain is radiation sickness, he had nosebleeds and other symptoms of that. And his medical record will show that. Later he developed leukemia.

Now, do you not think he should be treated as fairly as was the man who in 1945 received 0.89 rem?

Dr. SMITH. Doctor, much as I might like to answer that question, I am advised by counsel that this case is under advisement or under examination, and I am not entitled to answer it.

Mr. CARTER. Thank you.

Mr. ROGERS. Now, let me just ask a question or two, and then we will try to conclude it, and we will ask for certain information. Is this a guideline that you give to your regional offices?

Dr. HABER. No, sir.

Mr. ROGERS. Are there any guidelines that have been put out?

Dr. HABER. Each case must be considered on its own merits. The totality of the case must be considered, length of service and length of exposure, and so on.

Mr. ROGERS. Would you let us have whatever guidelines have been put out in these cases, make that available for the record?

Dr. HABER. Yes, sir. Such guidelines will be developed in the near future.

Mr. ROGERS. And also, let me ask, Dr. Moloney, is radiation cumulative, or not?

Dr. MOLONEY. Yes, it is.

Mr. ROGERS. It is. Is there any question about that in the scientific community?

Dr. MOLONEY. No, none whatsoever.

Mr. ROGERS. I see. So, if you may have had a little bit here, and a little bit elsewhere, it could accumulate and be a causative factor.

Dr. MOLONEY. Yes. That is why people keep radiation records and wear monitoring devices; exactly.

Mr. ROGERS. Although not too well done, often.

Dr. MOLONEY. I am speaking of our civilian practices in radiation laboratories, that sort of thing.

Mr. ROGERS. Now, should we require dentists, people who use Xrays, radiologists to keep a record and advise the patients?

Dr. MOLONEY. It is being done.

Mr. ROGERS. I have never been advised.

Dr. MOLONEY. People who work there have records.

Mr. ROGERS. I am talking about the patient, not the people who are directing the machine zapping someone else. I am talking about the people who get zapped, the patients.

Dr. MOLONEY. That has been strongly advocated, it is an enormous task.

Mr. ROGERS. I understand that. You would support that?

Dr. MOLONEY. I think if people are exposed to repeated chest Xrays, repeated GI series, or any amount of radiation——

Mr. ROGERS. Well, if it is cumulative, should not a record be kept?

Dr. MOLONEY. Right, absolutely.

Mr. **Rogers**. I think if you would let us also have the cases from the regional office that you did not have the details on, if you could get that for us, sir, it would be helpful. And we would like to know—I think we said that—the complete number of claims filed, the total number; when the first cases of radiation exposure were filed, and when was the first atomic blast claim filed.

Also, I would like for the agency to comment on this question. In a case where a man's official record may not establish where he was because the records were poorly kept, could you tell us what the general attitude of the agency is on claims of this nature. And then, of course, many men did not even have radiation badges to show what the exposure was; what is the agency's general attitude on this with regard to radiation cases and claims.

We are sorry to have held you for so long. We probably will want to ask more questions and to gain your help on this problem, it is a serious one. I think we have many people that have been exposed that this committee plans to follow rather carefully.

I want to commend you for stating in the hearing that your agency will cooperate fully with CDC, DOE, DOD, or any other agency. If you could furnish the material which we have requested for the committee as soon as possible it will be appreciated.

Thank you for your presence here today.

Dr. **Haber**. Thank you very much, Mr. Chairman.

Mr. **Rogers**. This will conclude the hearings for today. I think the next hearing is February 8, on this subject matter.

The committee stands adjourned.

[Whereupon, at 2:10 p.m., the subcommittee adjourned, to reconvene on February 8, 1978.]

EFFECT OF RADIATION ON HUMAN HEALTH

Health Effects of Ionizing Radiation

WEDNESDAY, FEBRUARY 8, 1978

House of Representatives,
Subcommittee on Health and the Environment,
Committee on Interstate and Foreign Commerce,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10 a.m., in room 2322, Rayburn House Office Building, Hon. Paul G. Rogers, chairman, presiding.

Mr. Rogers. The subcommittee will come to order, please.

During the next 2 days of oversight hearings on low-level ionizing radiation, the Subcommittee on Health and the Environment will be examining the most recent epidemiological studies linking the induction of cancer to exposure to radiation.

As we heard in our first day of hearings, it is now, we think, generally accepted that cancer and leukemia may be induced by ionizing radiation, and that there does not exist a so-called safe level of exposure below which there is zero risk of radiation-induced cancer. The important remaining question is to determine just how great the risk of a particular exposure to radiation actually is. A number of studies have been conducted to attempt to answer this question. The data on survivors of the Japanese atomic explosion suggested that the risk was relatively low, but other studies on those exposed to lingering atomic bomb radiation after a blast but not exposed to the blast itself suggests a somewhat higher risk.

Studies of those receiving medical X-rays or radiation from iodine-131 used to threat thyroid problems suggest varying degrees of risk of cancer.

Many of these studies will be discussed during these 2 days of hearings, and we are pleased that a number of the scientists involved in them will be testifying as witnesses. There are, however, two particular studies upon which this particular subcommittee will be focusing.

These investigations, one involving the study of cancer deaths of the workers at the Hanford nuclear materials plant and the other examining the induction of cancer by medical X-rays, have two features in common. Both show a risk of cancer that is considerably higher than was previously believed, and both have had their funding terminated by the Federal agencies which had supported them for many years.

We will, therefore, be not only taking a close look at the scientific merit of these and other studies, but examining the actions of the Federal agencies that chose not to continue studies the results of which, if valid, raise serious questions about our widespread use of medical X-rays, the occupational standards for exposure to radiation, and the wisdom of current safety standards in the nuclear power industry.

Thus, it is absolutely essential that we clarify these particular cases as thoroughly as possible. I think it is important we completely understand the nature and magnitude of the risk to human health from radiation exposure, and there should be no question of the integrity of our Federal agencies which support research programs into questions which may yield unpopular answers.

Some serious issues have been raised, and it is my hope that these 2 days of hearings will help to resolve them.

Dr. Carter, I believe, has a statement.

Mr. CARTER. Thank you, Mr. Chairman.

Mr. Chairman, it is good to be here to participate in this second set of hearings on the health effects of low-level ionizing radiation. As you know, there has been a longstanding controversy about the risk to human health from exposure to such levels of radiation, and in recent years this contreversy has intensified. Today and tomorrow we will have an opportunity to examine two controversial studies in this field, one by Dr. Thomas Mancuso, Dr. Alice Stewart and George Kneale and the other by Dr. Irwin Bross. Each of these shows an increased risk of cancer from exposures to low levels of ionizing radiation, levels within our current standards of occupational exposure.

Moreover, these researchers believe that their Federal funding was not renewed because of the controversial nature of their findings. These are serious issues which deserve our subcommittee's careful examination. Dr. Mancuso's study, which we will consider today, examined the mortality experience of Federal nuclear workers at the Hanford atomic facility in Richland, Wash.

In this study, Dr. Mancuso, Dr. Stewart, and George Kneale, found that approximately 5 percent of the male cancer deaths among Hanford workers were radiation-induced. In other words, about 35 of the 743 male cancer deaths could be attributed to the workers' exposure to low levels of ionizing radiation.

Furthermore, Mr. Chairman, I would like to add that at this time we know of 10 veterans in my home State of Kentucky exposed to atomic test blast. Six of those ten report or have had cancer, of which one-third, or two, have had leukemia. Of the remaining four without cancer, one is the father of a child with birth defects.

Mr. Chairman, there is no doubt but that the effects of ionizing radiation are extremely dangerous, and, of course, it has been known for many years that overexposure does cause cancer. We are now building evidence that exposure to low-levels is also hazardous to human health.

Thank you, Mr. Chairman.

Mr. ROGERS. Thank you, Dr. Carter.

Mr. Walgren, do you care to say anything?

Mr. WALGREN. I have no opening statement.

Mr. Rogers. I will ask Dr. Carter to introduce the first witness, who is from Kentucky.

Mr. Carter. Mr. Chairman, it is my pleasure to introduce Mr. Tounsel Howard, from near Hindman, Ky., although I sincerely regret the physical condition he now suffers. He happens to be a cousin of my colleague in the Congress, Carl Perkins. He is one of the men who has been exposed to the atomic blasts conducted by the military and AEC. He is now suffering from lymphoma and I would hope that he could fully recover, but the chances as he knows, are not all that good.

Mr. Howard, would you come up, please?

Mr. Rogers. Mr. Howard, the committee welcomes you. We are pleased to have you here, and we appreciate your coming. You may have a seat. If you have a prepared statement, it will be made a part of the record in full, and you may proceed as you desire. It might be well to pull the mike a little closer.

STATEMENT OF TOUNSEL HOWARD, LEEBURN, KY.

Mr. Howard. Mr. Chairman and members of the committee, I was assigned to the 25th–96th Air Force Reserve Flying Center at Hinsley Field, Tex., now known as Dallas Naval Air Station, Dallas, Tex. I was told by an administrative officer at Hinsley Field, Tex., to report to the orderly room for a screening of my personnel records, and he stated after my arrival that he had screened my records, had seen that I had graduated from a CBR, chemical, biological, and radiological, war school at Lowary Air Force Base in Denver, Colo.

At this point he noted that I had a top secret clearance, and asked me if I would be willing to go to an advanced course in radiological warfare at Nellis Air Force Base in Las Vegas, Nev. I stated that I would.

I departed for Nellis Air Force Base on the 1st of June, 1957, had about 3 weeks' training in radiological warfare defense, and was told at this point that I would witness an actual bomb test and would be taking surveys with a Geiger counter to ground zero.

Approximately 1 week later we reported to Desert Rock at approximately midnight, and waited approximately 3 hours, and then were told that the bomb tests were off due to the weather conditions and so forth. The following night we reported back to Desert Rock, and after approximately 1 hour's waiting, we were told by the briefing officer that the bomb test would be conducted.

We departed for the test area at this time, a designated spot at Yucca Flats for the test. It is known, to the best of my recollection, to be Wilson, is the code name of the bomb.

Approximately 3 hours later, in the desert, we were given the final word, and countdown began at 50. At approximately 10 minutes before the explosion we were told to face away from the bomb blast, covering our eyes, and to remain in that position until after the explosion, and to not look in the direction of the bomb during this time. The countdown continued, and the explosion, as best I can remember, was a tremendous blast, and the whole desert lit up completely around me.

The next thing I could remember, they told us, and I remember counting 10, and then some of the personnel in my group, which numbered about 46, began to roll through the desert floor, but I remained standing upright. My helmet was blown from my head at this time. I managed to put my foot on my helmet, got the helmet back on my head. The group got back together as best they could.

I turned and looked in the direction of the detonation. At this point I saw a tremendous ball of fire rising from the desert floor, and it continued to churn and go up into the air. It was of all colors of the rainbow, and the fire continued to rise above the desert floor. At the base of this ball of fire was a tremendous churning of the earth and clouds beginning to form at the base of the explosion as the fire ball continued to rise in the air. After the fire ball was several hundred feet in the air, to the best of my ability to judge this, the fire ball began to break up into just flames, and continued to shoot into the air with smoke coming out from the flames, a tremendous black smoke.

Upon this subsiding, we continued to wait for word from the briefing officer to proceed into the area of the bomb blast. Our assignment in this test was to monitor radiation at ground zero. The area was marked off and staked off with stakes, and we waited approximately 1½ hours, to the best of my ability to remember, and then the word came from the command post to our briefing officer, project officer, to proceed in Jeeps, monitoring the radiation, and also we would give the miles on the spedometer of the Jeeps of the miles we proceeded, which in turn would be reported in to the command post.

We proceeded on to ground zero, and I could see burnt earth from where the Jeeps were. I could not estimate the exact distance that we were from this, and I cannot recall the exact radiation on the Geiger counters, the readings that were on the Geiger counters at the time. We continued to monitor, reporting our findings, and surveying the situation, buildings, vehicles, and so forth.

We noted buildings being blown completely apart—some buildings were just matchsticks—and noted vehicles with their tops blown completely caved in. I particularly remember a tank with the hatch blown off, and it, you could say, was totally demolished.

We monitored on for approximately 1 hour, I guess to the best of my recollection, and then I remember the officer in charge of our group stating that we had the allotted dosage of radiation and we would clear the area at this time. We got back in our Jeeps. We proceeded out to the main road, and loaded aboard Air Force buses, and upon getting out about 1 mile, the officer told us to unload out of the buses. We unloaded. They took the Geiger counters which we had with us. They monitored for the effects of radiation, gave us the all-clear.

We loaded back aboard buses. We proceeded away from the bomb blast area, and approximately 1 mile going back towards the main highway, Desert Rock, we noted on the lefthand side of the road a group of Army personnel taking showers with makeshift showers, and they were completely covered with dirt, debris, and what have you. We proceeded on out of the area, and went directly to Indian Springs. It is an auxilliary Air Force Base.

At this base, we were more of less debriefed by the briefing officer, and proceeded on to Nellis Air Force Base at Las Vegas, Nev.

I retired in April of 1966 from the Air Force, from 20 years of service, and went to my home in Leeburn, Ky., to live. The latter part of November of 1976, I began to get weak and dizzy spells. I began to lose weight. I began to vomit. At times I would get completely—I would almost completely black out.

Then, in July of 1977, I began to notice shortness of breath, swelling of my feet, swelling of my legs, and I had lost by this time approximately 50 pounds. At this time I decided to go to Rickenbacker Air Force Base at Columbus, Ohio, for a complete medical examination. This was around the 17th of July in 1977.

The Air Force doctor found, as I stated, swelling of the feet and fluid in my lungs, and he asked me if I could report to the U.S. Air Force Medical Center at Wright Patterson Air Force Base for further evaluation.

On the 18th of July of 1977 I was admitted to the Air force base hospital, the U.S. Air Force base hospital, and after 1 month's evaluation and medical exams, I was told by Capt. William Jones, M.D., of the Air Force Medical Center, of Wright Patterson Air Force Base, that my diagnosis was malignant lymphoma.

I asked the doctor at this time, Dr. Jones, if it was possible that radiation could have caused my illness. He gave me an answer that he could not answer the question. He did go on to say that it was a possibility.

I remained in the hospital after this, and I was told that my case, my medical history, was being referred to the Armed Forces Institute of Pathology for their evaluation. A short time later, the word was given to me by Dr. Jones that they had agreed with the diagnosis. I was started on chemotherapy the 17th of August, 1977.

After a few treatments of chemotherapy, my blood count was lowered in such a condition I was unable to continue my chemotherapy at that time. I was told that I could go home and return at a later date for my chemotherapy. I went home and stayed approximately 3 weeks, and returned to Wright Patterson Air Force Base, and was given chemotherapy at this time.

In the meantime, after chemotherapy, Dr. Donald M. Shapiro, a hemotologist, told me that he was getting out of the service, he was being discharged, and that the doctor that was in his department would be unable to continue my treatment, and I should look for treatment at another Air Force Base.

At this point, and in my condition, it began to worry me, and I called the Honorable Carl D. Perkins of the Seventh Congressional District of Kentucky and asked him if it would be possible to get me into a VA hospital near my home, as the driving back and forth, and my blood count being in the condition it was, that possibly I could get treatment at these facilities.

The Honorable Carl D. Perkins in turn contacted the VA center in Johnson City, Tenn., Mountain Home, Johnson City, Tenn., and Dr. O. C. Bremly of the VA Center at Mountain Home stated he would treat me at this facility. I departed from Johnson City, and was admitted to the hospital for chemotherapy there. I continued by chemotherapy there and returned home.

In the latter part of this month, my face began to swell, and I began to get dizzy spells again, due to not being able to take chemotherapy. On the 6th of this month, I was due for chemotherapy treatment. I called Dr. O. C. Bremly and told him that if at all possible, I would like to appear before a committee in Washington, and if it would be possible for me to appear.

He stated that he thought that it would be all right, and at this time I asked Dr. Bremly, O. C. Bremly, if he thought that due to my being in a test area where nuclear bombs were exploded, that it could have caused my illness of lymphona. Dr. Bremly stated that it is very possible and highly likely that this was the cause of my illness. He also stated that the tumor that I have is the very such tumor that is caused by radioactive dust and so forth.

In closing, Mr. Chairman and members of the Committee, I would like to thank each one of you for allowing me the honor to appear before your committee in the matter. Thank you.

Mr. ROGERS. Thank you, Mr. Howard. We do appreciate your making the effort to come before the committee to let us hear of your experience, and we certainly will have this checked into very carefully along with the other cases now being reported to the committee from all over the country.

I might say that we are having telephone calls and letters from people who were exposed to radiation and are now having problems with cancer. All of these cases will be checked out. We are indebted to you for being here to let us know of your paticular case.

Are there any questions?

Mr. CARTER. I have just a few, Mr. Chairman.

When you went into the blast area, did you wear a mask or any protective gear?

Mr. HOWARD. No, sir, we did not, sir.

Mr. CARTER. Did you inhale any of the dust in that area?

Mr. HOWARD. I would say that we did, sir. I would say that we did.

Mr. CARTER. Yes, sir. Were you on sick call within a few days after you had been exposed?

Mr. HOWARD. No, sir. I was not, sir.

Mr. CARTER. Your health problems did not begin until 1976. Is that correct?

Mr. HOWARD. That is correct, sir.

Mr. CARTER. Is it correct that your doctor says a possible cause of your condition is your exposure to this atomic blast?

Mr. HOWARD. That is correct, sir.

Mr. CARTER. Were you warned of any possible adverse health effects by the military before your participation in these maneuvers?

Mr. HOWARD. No, sir. I was not, sir.

Mr. CARTER. Thank you very kindly.

Mr. ROGERS. Mr. Walgren?

Mr. WALGREN. Just very briefly, Mr. Howard, you say that you had 3 weeks of special training prior to the blast. Did they make you aware of the risks of radiation in any way during those 3 weeks?

Mr. HOWARD. I cannot recall of any, sir.

Mr. WALGREN. So when you went into the blast as a soldier, you were not particularly apprehensive about the impact that that might have on you?

Mr. HOWARD. No, sir, I was not, sir.

Mr. **Walgren**. Then in the years following the blast, I understand you took the initiative to go to the service hospital in 1976. Had you been followed by the service in any way between the blast and the time that you reported to the hospital? Did they contact you to monitor your health or check on your health in any way?

Mr. **Howard**. No, sir, they did not, sir.

Mr. **Walgren**. Thank you.

Mr. **Rogers**. Let me just ask one question. Do you recall having been issued any type of a radiation film badge prior to participation in the test?

Mr. **Howard**. The only time I remember that I was issued a film badge was when I was involved in the first schooling at Lowry Air Force Base in Denver, Colo.

Mr. **Rogers**. But you were not given a badge before this particular test?

Mr. **Howard**. No, sir.

Mr. **Rogers**. Thank you so much Mr. Howard. We are grateful for your being here.

Mr. **Howard**. Thank you, sir.

Mr. **Rogers**. The next witness will be Dr. Samuel D. Milham, who is with the Department of Social and Health Services, Environmental and Epidemiology Section, State of Washington.

We welcome you, Dr. Milham. Your statement will be made a part of the record in full, and you may proceed as you desire. We appreciate your being here.

STATEMENT OF SAMUEL MILHAM, JR., M.D., POPULATION STUDIES UNIT, WASHINGTON STATE DEPARTMENT OF SOCIAL AND HEALTH SERVICES

Dr. **Milham**. Mr. Chairman, subcommittee members, my name is Samuel Milham, Jr. I am a physician employed by the Washington State Department of Social and Health Services in Olympia, Wash. I am supervisor of the Population Studies Unit. I am a chronic disease epidemiologist, and I am certified by the American Board of Preventive Medicine.

Between 1971 and 1974——

Mr. **Rogers**. Exuse me, may I ask who has put the other mike on the table?

Voice. It is mine.

Mr. **Rogers**. Whom are you representing?

Voice. I am an independent filmmaker.

Dr. **Milham**. Between 1971 and 1974, I did a study on the men who died in Washington State in the years 1950 to 1971. This study encompassed over 300,000 deaths. A number of industrial and occupational groups showed excess mortality. Men who worked at the Atomic Energy Commission Hanford facility in Richmond, Wash., showed increased mortality from cancer, especially in men under age 64 at death. An excess was seen for cancers of the tongue, mouth, and pharynx, colon, pancreas, lung, and bone. Excess mortality was also seen for aplastic anemia and amyotrophic lateral sclerosis.

In May 1974, I prepared a manuscript describing this mortality excess, but before submitting the manuscript for publication, I sent a copy of it to Dr. Thomas Mancuso, then a contractor for the

Atomic Energy Commission, and delivered a copy to the AEC staff at a meeting at Hanford on June 26 and 27, 1974. I am attaching a copy of that manuscript for the record, attachment No. 2 [see p. 497].

Mr. ROGERS. The manuscript will be received as a part of the record.

Dr. MILHAM. This paper suggested that inhalation and or ingestion of radioactive materials might be responsible for the cancer excess, and suggested that a population-based followup study should be done.

At Hanford, I met with Dr. Barkev Sanders, statistician on Dr. Mancuso's study, and with AEC and Hanford Environmental Health Foundation personnel, to go over my findings and to learn of the details of the Mancuso study. The impression I got at the meeting with AEC was that release of my finding might cause concern and problems in the industry. After this meeting, I decided not to publish my study, because I was convinced that the appropriate population-based studies were in progress. I felt that publication of my findings at this time might disturb the continuity of the study in progress and might cause undue concern in the workers. I perceived no immediate added danger to the workers. These impressions are documented in a memorandum, dated June 28, 1974, I wrote to Dr. John Beare, director of my agency, when I returned from Hanford, attachment No. 3 [see p. 502].

Mr. ROGERS. Without objection, it will be made a part of the record.

Dr. MILHAM. I cooperated in every way possible with Dr. Mancuso, Dr. Sanders, and the AEC, making all of my basic data and death records available. My basic findings were subsequently published in abbreviated form in 1976 as part of a National Institute for Occupational Safety and Health monograph. That is attachment No. 4 for the record also [see p. 503].

AEC, and later ERDA, commissioned work at Battelle Northwest Laboratories to examine my findings. I am attaching selected tables and excerpts from a document prepared by Ethel Gilbert, attachment No. 5 [see p. 514].

Mr. ROGERS. All of the attachments will be made a part of the record without objection.

Dr. MILHAM. This work supports my initial findings in great detail and, more importantly, suggests to me a positive cancer/radiation exposure relationship. You see, I had no basic radiation data in my work. I feel strongly that the worker population at Hanford should be studied on a continuing basis, since it is one of the few populations available with monitored low-dose radiation exposure. I feel that the responsibility for carrying out these studies should not reside in ERDA or among the ERDA contractors.

Thank you.

[Testimony resumes on p. 517.]

[Attachments to Dr. Milham's prepared statement follow:]

Attachment 2--UNPUBLISHED MANUSCRIPT, JUNE 1974

Increased Cancer Mortality
Among Male Employees of the Atomic Energy Commission Hanford, Washington, Facility.

Abstract

Analysis of the death certificates of 842 Hanford Project employees as part of a statewide occupational mortality study revealed a 25% cancer excess in the years 1950-1973 in men age 20 to 64 at death. An excess was seen for cancers of the tongue, mouth and pharynx, colon, pancreas, lung and bone. Also seen was an excess of amyotrophic lateral sclerosis and aplastic anemia. Ingestion and/or inhalation of carcinogenic materials is suggested by the cancer pattern. These findings support the hypothesis that an occupational hazard exists for Hanford employees. A population based study should be done to confirm or reject this hypothesis.

As a first step in studying occupational mortality patterns in Washington State, the death records of all male residents, age 20+, dying in the years 1950-1971 were searched, and the occupational statement abstracted and coded. A three-digit occupational code, based on the U.S. Census Bureau occupational code(1) was then punched into the existing death punch cards and the cards read onto magnetic tape. Code modifications were designed to take advantage of occupations and industries unique to this area. Therefore, rubrics were added to handle occupations in the wood products industry, the aircraft industry (Boeing in Seattle) and the nuclear industry (Hanford Works in Richland). The completed file contained 307,828 records.

A preliminary tabulation of the records (occupation by cause of death) revealed a high proportion of cancer deaths among Hanford workers (22.5% for Hanford employees versus 16.1% for all deaths). Since the deaths coded to Hanford were those occupations peculiar to the industry (i.e. reactor operator, nuclear engineer, etc.) an effort was made to identify all other Hanford deaths including those coded to non-specific occupations (carpenter, storekeeper, bus driver, etc.). Therefore, all death records for the three counties around Richland, Washington (Benton, Franklin and Yakima), filed in the years 1950-1973, were examined. Records of men whose occupational statement listed Hanford, Atomic Energy Commission or an A.E.C. contractor were considered those of Hanford employees. In all, 842 such records were identified.

Deaths were tabulated by cause of death and age. Expected deaths were derived using a proportionate mortality approach(2).

Table 1 shows good agreement in observed and expected deaths for the non-cancer causes of death. However, there is a statistically significant excess of observed cancers to expected cancers, with the excess being confined primarily to men dying between ages 20-64. There is a 26% excess of cancers in this group(3). Table 2 shows that the cancer excess is due mostly to gastrointestinal cancers. Tongue, mouth and pharynx, colon and pancreas show significant excesses in men age 20-64 at death. Men dying over age 65 show an excess only for cancers of the mouth and pharynx. Lung and bone cancer show an excess if both age classes are added ($P < .05$). Stomach, rectum, prostate, kidney and urinary bladder cancers show no excess. Of the lymphatic-hematopoietic system cancers, only multiple myeloma shows an excess (not statistically significant). Aplastic anemia and amyotrophic lateral sclerosis show excess mortality. Aplastic anemia was studied because of its known relationship to radiation. Amyotrophic lateral sclerosis was studied because 3 deaths were ascribed to this cause among the 72 deaths filed in 1972 and 2 among the 57 filed in 1971.

In terms of secular trend, 4 of 4 tongue cancer deaths occurred in 1970-1972, 7 of 16 colon cancers occurred in 1971-1973, 6 of 18 pancreatic cancers occurred in 1962-1964, and 5 of 6 amyotrophic lateral sclerosis cases occurred in 1971-1972. The other cancer cases were spread fairly evenly over the study period.

The cancer of colon age at death pattern was unusual in that 7 of 16 cases occurred in men age 40-49 at death (observe 7, expect 1.28; $X_1^2 = 25.56$, $P < .001$).

In considering biases which might account for the observed cancer excess, it is difficult to conceive of a bias operating on certain cancers and not others, on cancers and not other causes of death, and on cancers in certain age classes only.

The specific types of cancer with excess deaths would suggest ingestion and/or inhalation of carcinogenic agents. Since the Hanford facility is involved in the handling, fabrication, processing and storage of an array of radioactive materials, most of which are of proven carcinogenicity, I suggest that these materials are the most likely cause for the observed cancer excess(5).

I feel that the findings of this study support the hypothesis that there is an occupational hazard to Hanford employees. Confirmation or rejection of this hypothesis must await an employee population based mortality study.

Samuel Milham, Jr., M.D.
Washington State Department of Social
and Health Services
Health Services Division
P. O. Box 1788
Olympia, Washington 98504

May 24, 1974

References and Notes:

1. Classified Index of Occupations and Industries, 1960 Census of Population, U.S. Bureau of Census.

2. See L. G. Guralnick, Vital Statistics-Special Reports 53, No. 5, 441 (1963) for details of this method. Total deaths and the cause of death to be examined are counted by 5 year age groups for the entire file, and the proportion of deaths due to the examined cause is calculated in each age class. This proportion is then multiplied by the total Hanford deaths in each age class to get the expected deaths due to that cause in each age class in Hanford employees. Observed deaths for that cause are tabulated by age, and observed and expected deaths are summed over age and compared using a chi-squared test. A small but negligible bias is introduced because the Hanford deaths cover the years 1950-1973, whereas the total state death file covers the years 1950-1971.

3. The 26% figure pertains to all employee deaths. Since many men work in occupations with no obvious hazard (accountants, buyers, administrators, etc.), the 26% cancer figure probably understates the risk for men in hazardous occupations.

4. Not included are 7 cancers reported in part II of the cause of death statement on the death certificate. For example, suicide or sudden death due to cardiovascular disease in part I of the cause statement takes precedence for assignment of cause of death.

5. Although there were only 3 bone tumors, one was a fibrosarcoma of the tibia, and there was an additional "fibrosarcoma of the thigh" (coded to a connective tissue rubric). Osteogenic fibrosarcoma was the histologic type of tumor seen in the radium dial workers (see W. C. Hueper, Occupational Tumors and Allied Diseases. C. C. Thomas (1942) page 642). Also, experimentally induced radiation sarcomas are of this histologic type (see Hueper, page 685). Bone seeking radionuclides may also explain the excess aplastic anemia and the slight multiple myeloma excess.

I can offer no explanation for the remarkable amyotrophic lateral sclerosis excess.

Table 1
Observed and Expected Deaths of Male Hanford Employees
by age and grouped causes of death, 1950-1973

Cause of Death	ICD No.*	Age at death	Deaths Observed	 Expected	X_1^2**	P***
All Cancers (4)	140-209	20-64	118	93.3	6.5	<.025
		65+	55	54.7	.002	N.S.‡
		20+	173	148.0	4.2	<.05
All Other Causes	000-136 210-999	20-64	414	439.7	1.5	N.S.
		65+	255	255.3	.0004	N.S.
		20+	669	695.0	1.0	N.S.

* International Classification of Diseases, Eighth Revision

** X_1^2 = (Observed deaths - Expected deaths)^2 / Expected deaths

*** P = Probability that X_1^2 is equal to or greater than its stated value

‡ N.S. = Not statistically significant at the 5% level

Table 2
Observed and Expected Deaths
By cause and age for Hanford Employees, 1950-1973

Cause	ICD No.	Age	Deaths Observed	Deaths Expected	X_1^2	P
Malignant Neoplasm of:						
Tongue	141	20-64	4	.75	14.08	<.001
		65+	0	.27	.27	N.S.
Mouth and Pharynx	144-147	20-64	1	1.49	.16	N.S.
		65+	3	.47	13.62	<.001
Stomach	151	20-64	6	6.91	.12	N.S.
		65+	3	5.81	1.36	N.S.
Colon	153	20-64	15	6.68	10.36	<.005
		65+	1	5.29	3.48	N.S.
Rectum	154	20-64	1	3.40	1.69	N.S.
		65+	3	2.50	.10	N.S.
Pancreas	157	20-64	13	5.95	8.35	<.005
		65+	5	3.71	.44	N.S.
Lung	162-163	20-64	36	28.89	1.74	N.S.
		65+	18	12.46	2.46	N.S.
Bone	170	20-64	2	.59	3.37	N.S.
		65+	1	.22	2.57	N.S.
Prostate	185	20-64	4	3.01	.32	N.S.
		65+	5	7.49	.83	N.S.
Urinary Bladder	188	20-64	1	2.54	.93	N.S.
		65+	1	2.50	.90	N.S.
Kidney	189.0-189.1	20-64	6	2.85	3.48	N.S.
		65+	1	1.26	.05	N.S.
Brain	191	20-64	5	4.65	.03	N.S.
		65+	2	.69	2.49	N.S.
Lymphosarcoma and Reticulum-cell sarcoma	200	20-64	4	3.12	.25	N.S.
		65+	1	1.14	.02	N.S.
Hodgkin's Disease	201	20-64	3	2.27	.23	N.S.
		65+	0	.41	.41	N.S.
Multiple Myeloma	203	20-64	2	1.35	.31	N.S.
		65+	2	.77	1.96	N.S.
Leukemia	204-207	20-64	2	3.96	.97	N.S.
		65+	4	2.33	1.20	N.S.
Aplastic Anemia	284	20-64	0	.26	.26	N.S.
		65+	2	.19	17.24	<.001
Amyotrophic lateral sclerosis	348.0	20-64	3	.62	9.14	<.001
		65+	3	.21	37.06	<.001

Attachment [illegible]

State of
Washington
Department
of Social & Health
Services

To: Health Services Division
Mail Stop 17-6
John Beare, M.D.

Date June 28, 1974

From. Non-Communicable Diseases Unit
Mail Stop 2-2
Samuel Milham, Jr., M.D.

On June 26 and 27 I visited Dr. Barkev Sanders at the Atomic Energy Commission's Hanford facility in Richland. The purpose of my visit was to discuss the excess of cancer which I noted in Hanford employees in my Washington State Occupational Mortality Study.

I shared my case and population data with Dr. Sanders who designed and is executing the continuing study of mortality in Hanford employees under an AEC contract. His data supports mine in every detail and is more extensive in that he has complete ascertainment and follow up on all employees and has additional medical, work experience and radiation data for each employee. I am satisfied that the AEC study is properly designed and I can make no suggestions for improvement in the way their data is organized or is being analyzed.

I have offered continued collaboration in terms of providing basic population data to Dr. Sanders as needed. AEC will pay any necessary data processing costs.

I think that the timing of my study was fortunate in that is pinpointed areas to be examined in the Hanford data and may have accelerated the analysis. I am convinced that they would have found the same thing in their routine analysis anyway. AEC and Battelle Northwest have offered to cooperate in any way necessary to see the matter through to its logical conclusion.

In summary, I think that the matter is well in hand and that all that should be done is being done.

Attachment 4

NIOSH RESEARCH REPORT

VOLUME I

OCCUPATIONAL MORTALITY IN WASHINGTON STATE

1950 - 1971

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE / CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

VOLUME I

OCCUPATIONAL MORTALITY IN WASHINGTON STATE

1950-1971

Samuel Milham, Jr., M.D.
Chronic Disease Epidemiologist
University of Washington
and
Washington State Department of Social and Health Services
Health Services Division
Olympia, Washington 98504

Contract No. CDC-99-74-26

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health
Division of Surveillance, Hazard Evaluations, and Field Studies
Cincinnati, Ohio 45202
April 1976

HEW Publication No. (NIOSH) 76 – 175 -A

Upholsterers
Occupation code 535
Total deaths 289

Chronic rheumatic heart disease, arteriosclerotic heart disease in men age 20-64, and diseases of arteries (1950-60) show excess mortality. A non-significant PMR elevation is seen for urinary bladder cancer.

Craftsmen and Kindred Workers
Occupation code 545
Total deaths 344

Cerebral hemorrhage (age 20-64), subarachnoid hemorrhage and cancer of the kidney show PMR elevations based on small numbers.

Officers and Enlisted Men, Navy and Coast Guard
Occupation code 551
Total deaths 1,315

Officers and Enlisted Men; Air Force, Army and Marine Corps
Occupation code 555
Total deaths 2,590

PMRs are artificially elevated for a number of causes of death because of referral of ill armed servicemen to the large military medical centers in this state. Also, men retired for medical reasons are more likely to take up residence near the military medical facilities in the state. These populations have a high risk of dying and inflate the PMR for these two occupational classes.

Boeing Workers
Occupation code 557
Total deaths 2,511

This is an industrial grouping of men employed by a large aircraft manufacturing firm in the Seattle area. These men show significant elevations of PMR for acute leukemia, other specified anemias (ICD 292), paralysis agitans (1961-71) and coronary heart disease. Other causes with non-significant increases in PMR are cancer of the pancreas and Hodgkin's disease.

Atomic Energy Workers
Occupation code 558
Total deaths 727

This is the group of workers associated with the Atomic Energy Commission Hanford Project at Richland, Washington. The fact that twice as many deaths occurred in 1961-71 as 1950-60 is explained by the fact that the Hanford Project started in 1941 and the work force is now aging to the point where higher mortality rates prevail.

Cancer of the pancreas shows a significant PMR elevation in both time periods. Cancer of the large intestine shows an elevated PMR in men age 20-64. Examination of 1972 and 1973 deaths supports these findings and suggests that amyotrophic lateral sclerosis may also have an increased mortality in this industrial group.

In 1972 there were no pancreatic cancer deaths, 2 large intestinal cancer deaths (age 45-49) and 3 deaths due to amyotrophic lateral sclerosis. In 1973 there was 1 pancreatic cancer death (age 60-64), 1 large intestinal cancer (age 60-64), and no amyotrophic lateral sclerosis deaths.

Interestingly, the cancers associated with penetrating whole body radiatio show no remarkable PMR excess. Leukemias show lowered PMRs; multiple myeloma shows a small PMR increase based on 4 deaths. It may be that the colon cancer excess in young men is related to inhalation and/or ingestion of radionuclides. On the basis of gastrointestinal transit times, colon is the predicted site of maximal exposure to ingested radionuclides. The pancreatic cancer excess and the amyotrophic lateral sclerosis excess have no obvious relationship to radiation exposure. The colon cancer excess is corroborated by a population based mortality study(28).

Asbestos and Insulation Workers
Occupation code 630
Total deaths 136

Increased PMRs are seen for malignant neoplasms. Most of this excess is due to a very high PMR for respiratory cancers. Excess deaths are also seen in the category, diseases of the respiratory system, due primarily to asbestosis. A number of studies have reported this association(29).

Attendants; Auto Service, Parking, Gas Station
Occupation code 632
Total deaths 3,144

Unspecified pharyngeal tumors showed a 5 to 1.4 excess in men age 20-64. Tumors of testis (1961-71), tumors of unspecified sites, asthma, diabetes mellitus, cerebral hemorrhage and coronary heart disease also show elevated PMRs. The diabetes excess in men under age 35 is 10 deaths observed to less than 3 expected. The 1950 U.S. study does not show a comparable pattern.

Blasters and Powdermen
Occupation code 634
Total deaths 190

PMRs in the neighborhood of 600 are seen in the accidental death grouping (ICD 910-936) from work-related accidents

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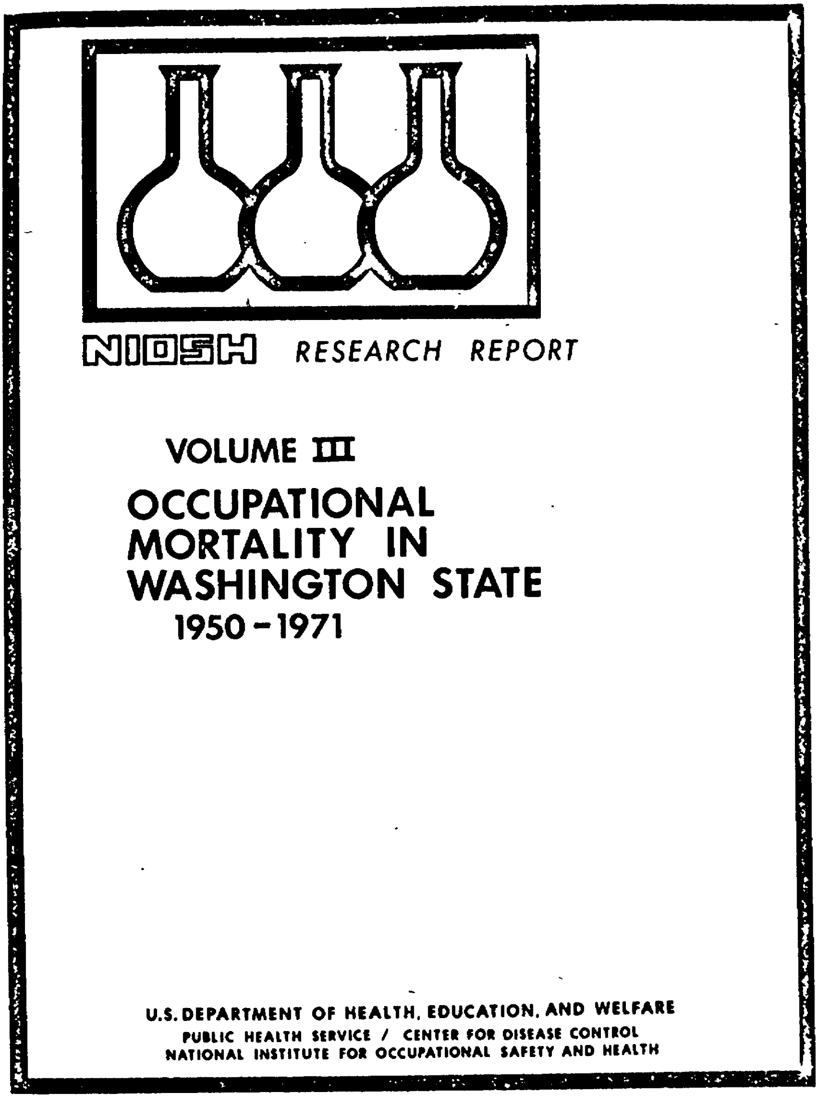

NIOSH RESEARCH REPORT

VOLUME III

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1950 - 1971

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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April 1976

HEW Publication No. (NIOSH) 76-175-C

PROPORTIONATE MORTALITY RATIOS, WHITE MALE DEATHS IN WASHINGTON STATE, 1950-1971
558 ATOMIC ENERGY WORKERS NEC

CAUSE OF DEATH	ICD NO.		1950-1960	1961-1971	1950-1971	20-64	AGE AT DEATH 20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+
TOTAL, ALL CAUSES	001-999	OBS	215	512	727	489	7	11	13	17	47	68	87	113	126	105	71	41	21
		EXP	215	512	727	489	7	11	13	17	47	68	87	113	126	105	71	41	21
		PMR	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
INFECTIVE AND PARASITIC DISEASES	001-138	OBS	2	1	3	2	0	0	0	1	0	1	0	0	0	0	1	0	0
		EXP	5	3	8	6	0	0	0	0	1	1	1	1	1	1	0	0	0
		PMR	44	33	40	32	0	0	0	R	0	R	0	0	0	0	R	0	0
TUBERCULOSIS (TOTAL)	001-019	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	3	2	4	3	0	0	0	0	0	1	1	1	1	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TUBERCULOSIS OF RESPIRATORY SYSTEM	001-008	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	2	1	4	3	0	0	0	0	0	0	1	1	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MALIGNANT NEOPLASMS	140-205	OBS	38	110	148	104	0	0	1	2	7	17	14	30	33	20	15	6	3
		EXP	35	99	134	89	0	1	2	2	6	11	16	23	27	21	14	7	2
		PMR	109	111	111	117	0	0	65	92	108	161	86	128	123	93	108	87	122
OF BUCCAL CAVITY AND PHARYNX	140-148	OBS	1	6	7	2	0	0	0	0	0	1	0	1	0	4	1	0	0
		EXP	1	3	4	3	0	0	0	0	0	0	1	1	1	1	0	0	0
		PMR	182	194	163	62	0	0	0	0	0	R	0	R	0	R	R	0	0
LIP	140	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TONGUE	141	OBS	0	3	3	1	0	0	0	0	0	0	0	1	0	2	0	0	0
		EXP	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	R	R	R	0	0	0	0	0	0	0	R	0	R	0	0	0
SALIVARY GLAND	142	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FLOOR OF MOUTH	143	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER PARTS OF MOUTH	144	OBS	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
		EXP	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	R	R	0	0	0	0	0	0	0	0	0	0	R	0	0	0
ORAL MESOPHARYNX	145	OBS	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	R	R	0	0	0	0	0	0	0	0	0	0	0	R	0	0
NASOPHARYNX	146	OBS	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	R	0	R	R	0	0	0	0	0	R	0	0	0	0	0	0	0
HYPOPHARYNX	147	OBS	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	R	R	0	0	0	0	0	0	0	0	0	0	R	0	0	0

PROPORTIONATE MORTALITY RATIOS, WHITE MALE DEATHS IN WASHINGTON STATE, 1950-1971
558 ATOMIC ENERGY WORKERS NEC

CAUSE OF DEATH	ICD NO.		1950-1960	1961-1971	1950-1971	AGE AT DEATH 20-64	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+
PHARYNX, UNSPECIFIED	148	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OF DIGESTIVE ORGANS AND PERITONEUM	150-159	OBS	16	36	52	40	0	0	1	1	2	7	4	13	12	5	4	3	0
		EXP	12	28	40	25	0	0	0	1	2	3	5	7	8	7	5	2	1
		PMR	138	127	130	158	0	0	R	R	124	210	85	196	150	73	87	132	0
ESOPHAGUS	150	OBS	1	2	3	3	0	0	0	0	0	0	0	2	1	0	0	0	0
		EXP	1	2	3	2	0	0	0	0	0	0	0	1	1	1	0	0	0
		PMR	R	88	107	167	0	0	0	0	0	0	0	R	R	0	0	0	0
STOMACH	151	OBS	5	6	11	8	0	0	1	0	0	2	1	2	2	1	1	1	0
		EXP	3	6	9	6	0	0	0	0	0	1	1	1	2	1	1	1	0
		PMR	156	106	124	143	0	0	R	0	0	R	93	146	108	68	98	R	0
SMALL INTESTINE INCLUDING DUODENUM	152	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LARGE INTESTINE, EXCEPT RECTUM	153	OBS	3	10	13	11	0	0	0	0	1	3	1	1	5	0	1	1	0
		EXP	3	8	10	6	0	0	0	0	0	1	1	2	2	2	1	1	0
		PMR	109	130	125	175	0	0	0	0	R	R	R	59	250	0	74	R	0
RECTUM	154	OBS	1	3	4	2	0	0	0	1	0	0	0	1	0	1	0	1	0
		EXP	1	3	5	3	0	0	0	0	0	0	1	1	1	1	1	0	0
		PMR	71	91	85	67	0	0	0	R	0	0	0	R	0	R	0	R	0
BILIARY PASSAGES AND LIVER (PRIMARY)	155	OBS	0	2	2	2	0	0	0	0	0	0	0	1	1	0	0	0	0
		EXP	1	2	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	111	79	122	0	0	0	0	0	0	0	R	R	0	0	0	0
LIVER	155.0	OBS	0	2	2	2	0	0	0	0	0	0	0	1	1	0	0	0	0
		EXP	1	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	196	129	188	0	0	0	0	0	0	0	R	R	0	0	0	0
GALLBLADDER, DUCTS, AMPULLA OF VATER	155.1	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVER (SECONDARY AND UNSPECIFIED)	156	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PANCREAS	157	OBS	6	13	19	14	0	0	0	0	1	2	2	6	3	3	2	0	0
		EXP	2	6	9	6	0	0	0	0	0	1	1	1	2	2	1	0	0
		PMR	254*	204*	217*	247	0	0	0	0	R	R	172	405	182	195	R	0	0
PERITONEUM	158	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UNSPECIFIED DIGESTIVE ORGANS	159	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PROPORTIONATE MORTALITY RATIOS, WHITE MALE DEATHS IN WASHINGTON STATE, 1950-1971
558 ATOMIC ENERGY WORKERS NEC

CAUSE OF DEATH	ICD NO.		1950-1960	1961-1971	1950-1971	AGE AT DEATH 20-64	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+
OF RESPIRATORY SYSTEM	160-165	OBS	8	32	40	29	0	0	0	0	0	4	5	7	13	6	4	1	0
		EXP	9	34	43	30	0	0	0	0	2	3	6	9	10	7	4	2	0
		PMR	86	95	93	98	0	0	0	0	0	125	89	79	134	81	98	63	0
NOSE, MIDDLE EAR, ACCESSORY SINUSES	160	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LARYNX	161	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BRONCHUS, TRACHEA, LUNG (PRIMARY)	162	OBS	7	21	28	21	0	0	0	0	0	3	3	3	12	3	4	0	0
		EXP	7	24	31	21	0	0	0	0	1	2	4	6	8	5	3	1	0
		PMR	104	86	90	98	0	0	0	0	0	138	75	49	160	57	130	0	0
BRONCHUS AND LUNG	162.1	OBS	6	21	27	20	0	0	0	0	0	3	3	3	11	3	4	0	0
		EXP	4	24	29	19	0	0	0	0	1	2	3	6	7	5	3	1	0
		PMR	135	86	94	105	0	0	0	0	0	155	86	53	159	58	132	0	0
PLEURA	162.2	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LUNG, UNSPECIFIED PRIMARY OR SECONDARY	163	OBS	1	11	12	8	0	0	0	0	0	1	2	4	1	3	0	1	0
		EXP	2	7	9	6	0	0	0	0	0	1	1	2	2	2	1	0	0
		PMR	55	147	129	126	0	0	0	0	0	R	158	183	62	174	0	R	0
THORACIC ORGANS (SECONDARY)	165	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PROSTATE	177	OBS	1	6	7	3	0	0	0	0	0	0	1	0	2	1	1	1	1
		EXP	1	7	8	3	0	0	0	0	0	0	0	1	2	2	2	1	1
		PMR	74	89	87	113	0	0	0	0	0	0	R	0	129	55	56	81	R
TESTIS	178	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER MALE GENITAL ORGANS	179	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KIDNEY	180	OBS	4	3	7	6	0	0	0	0	1	2	1	2	0	0	1	0	0
		EXP	1	3	4	3	0	0	0	0	0	0	1	1	1	1	0	0	0
		PMR	355	113	185	223	0	0	0	0	R	R	R	R	0	0	R	0	0
BLADDER AND OTHER URINARY ORGANS	181	OBS	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
		EXP	1	3	4	2	0	0	0	0	0	0	0	1	1	1	1	0	0
		PMR	0	31	24	0	0	0	0	0	0	0	0	0	0	R	0	0	0
MALIGNANT MELANOMA OF SKIN	190	OBS	0	2	2	1	0	0	0	0	1	0	0	0	0	0	0	1	0
		EXP	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	R	142	81	0	0	0	0	R	0	0	0	0	0	0	R	0

PROPORTIONATE MORTALITY RATIOS, WHITE MALE DEATHS IN WASHINGTON STATE, 1950-1971
558 ATOMIC ENERGY WORKERS NEC

CAUSE OF DEATH	ICD NO.		1950-1960	1961-1971	1950-1971	AGE AT DEATH 20-64	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+
OTHER MALIGNANT NEOPLASM OF SKIN	191	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EYE	192	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BRAIN AND NERVOUS SYSTEM	193	OBS	1	5	6	5	0	0	0	1	0	0	1	2	1	0	1	0	0
		EXP	2	4	5	5	0	0	0	0	1	1	1	1	1	0	0	0	0
		PMR	62	134	112	108	0	0	0	R	0	0	R	193	R	0	R	0	0
BRAIN	193.0	OBS	1	5	6	5	0	0	0	1	0	0	1	2	1	0	1	0	0
		EXP	2	3	5	4	0	0	0	0	1	1	1	1	1	0	0	0	0
		PMR	64	148	121	116	0	0	0	R	0	0	R	R	R	0	R	0	0
THYROID GLAND	194	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER ENDOCRINE GLANDS	195	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BONE	196	OBS	1	3	4	3	0	0	0	0	0	0	0	1	2	0	1	0	0
		EXP	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	R	R	R	R	0	0	0	0	0	0	0	R	R	0	R	0	0
CONNECTIVE TISSUE	197	OBS	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0
		EXP	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	R	R	R	0	0	0	0	R	0	0	0	0	0	0	0	0
OTHER AND UNSPECIFIED SITES	199	OBS	0	4	4	3	0	0	0	0	0	1	0	1	1	0	0	0	1
		EXP	1	3	4	3	0	0	0	0	0	0	0	1	1	1	0	0	0
		PMR	0	118	93	104	0	0	0	0	0	R	0	R	R	0	0	0	R
LYMPHATIC AND HEMATOPOIETIC TISSUES	200-205	OBS	6	10	16	11	0	0	0	0	2	2	2	3	2	2	2	0	1
		EXP	5	10	15	11	0	1	0	1	1	1	2	2	2	2	1	1	0
		PMR	128	97	107	100	0	0	0	0	147	141	100	134	86	107	163	0	R
LYMPHOSARCOMA AND RETICULOSARCOMA	200	OBS	2	3	5	4	0	0	0	0	0	1	1	1	1	1	0	0	0
		EXP	1	3	4	3	0	0	0	0	0	0	1	1	1	0	0	0	0
		PMR	178	107	127	133	0	0	0	0	0	R	R	R	R	R	0	0	0
RETICULUM CELL SARCOMA	200.0	OBS	2	0	2	2	0	0	0	0	0	1	0	0	1	0	0	0	0
		EXP	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	R	0	R	R	0	0	0	0	0	R	0	0	R	0	0	0	0
LYMPHOSARCOMA	200.1	OBS	0	3	3	2	0	0	0	0	0	0	1	1	0	1	0	0	0
		EXP	1	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	185	127	106	0	0	0	0	0	0	R	R	0	R	0	0	0
HODGKINS DISEASE	201	OBS	2	2	4	3	0	0	0	0	0	1	1	1	0	0	0	0	1
		EXP	1	2	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	R	124	155	138	0	0	0	0	0	R	R	R	0	0	0	0	R

PROPORTIONATE MORTALITY RATIOS, WHITE MALE DEATHS IN WASHINGTON STATE, 1950-1971
558 ATOMIC ENERGY WORKERS NEC

CAUSE OF DEATH	ICD NO.		1950-1960	1961-1971	1950-1971	AGE AT DEATH 20-64	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+
OTHER LYMPHOMAS	202,200.2	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MULTIPLE MYELOMA (PLASMOCYTOMA)	203	OBS	0	4	4	2	0	0	0	0	0	0	0	1	1	0	2	0	0
		EXP	1	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	298	208	159	0	0	0	0	0	0	0	R	R	0	R	0	0
LEUKEMIA AND ALEUKEMIA	204	OBS	2	1	3	2	0	0	0	0	2	0	0	0	0	1	0	0	0
		EXP	2	4	6	4	0	0	0	0	0	1	1	1	1	1	1	0	0
		PMR	107	24	49	48	0	0	0	0	R	0	0	0	0	R	0	0	0
LYMPHATIC LEUKEMIA	204.0	OBS	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
		EXP	1	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	R	0	57	0	0	0	0	0	0	0	0	0	0	R	0	0	0
MYELOID LEUKEMIA	204.1	OBS	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0
		EXP	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	R	70	98	0	0	0	0	R	0	0	0	0	0	0	0	0
MONOCYTIC LEUKEMIA	204.2	OBS	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	R	0	R	R	0	0	0	0	R	0	0	0	0	0	0	0	0
ACUTE LEUKEMIA	204.3	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER AND UNSPECIFIED LEUKEMIA	204.4	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BENIGN NEOPLASMS	210-229	OBS	0	2	2	1	0	0	0	0	0	0	1	0	0	0	1	0	0
		EXP	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	R	189	R	0	0	0	0	0	0	R	0	0	0	R	0	0
NEOPLASMS OF UNSPECIFIED NATURE	230-239	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASTHMA	241	OBS	0	3	3	0	0	0	0	0	0	0	0	0	0	2	0	1	0
		EXP	1	2	3	2	0	0	0	0	0	0	0	1	1	0	0	0	0
		PMR	0	183	110	0	0	0	0	0	0	0	0	0	0	R	0	R	0
DISEASES OF THYROID GLAND	250-254	OBS	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	R	0	R	R	0	0	0	0	0	0	R	0	0	0	0	0	0
DIABETES MELLITUS	260	OBS	5	6	11	7	0	0	0	1	0	1	2	1	2	2	1	1	0
		EXP	2	7	10	6	0	0	0	0	1	1	1	1	2	2	1	1	0
		PMR	202	81	112	112	0	0	0	R	0	R	R	77	119	125	91	R	0
DISEASES OF OTHER ENDOCRINE GLANDS	270-277	OBS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		EXP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PMR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 5

PROPORTIONAL MORTALITY ANALYSIS
OF HANFORD DEATHS

by

E. S. Gilbert

Our data exhibit no clear-cut relationship of death from cancer and radiation exposure. With the possible exception of average dose, none of the variables produce any evidence of a consistent dose-cancer correlation. The SMR's for the various groups based on the two total exposure variables were corrected for years at Hanford, but this did not alter the results in any significant way.

It is important to note that with a 10 year latency period, there is little evidence yet in for total doses much larger than 2 rems. With a 20-year latency period, there is virtually no relevant data yet. Unfortunately, it will be at least 10 to 20 years before we can adequately examine total exposures in the range of 10 rems or more.

SPECIFIC CANCER TYPES

On Table 4, standard mortality ratios for the total group, for those with five or more years at Hanford, and for craftsmen and operators are presented. In Table 2, the relationship of a few selected causes with occupation and with dose is presented. It should be noted that the SMR's for less common causes of death within subsets of the data are subject to much random variation. Many of the trends noted below may well be chance occurrences.

Of the various specific cancer types, only cancer of the pancreas and cancer of other lymphatic tissue (includes multiple myoloma) are significantly high. Cancer of the pancreas is high for both short and long term workers. It is low in the lowest exposure group, and particularly high for younger and local deaths as well as for those with an early initial year of employment. Cancer of other lymphatic tissue is especially high for those with higher radiation doses. Leukemia, interestingly, is significantly lower than normal. Other cancers which are high for particular occupational groups include cancer of the colon and lymphosarcoma (both are high for chemical operators, steamfitters and other operators), and cancer of the lung (high for chemical operators and other craftsmen, slightly high for steamfitters and power operators). With the possible exception of cancer of other lymphatic tissue, there is no consistent relationship of any of these cancers with radiation exposure.

OTHER CAUSES OF DEATH

Infectious diseases, diseases of the nervous system and sense organs, pneumonia, diseases of the digestive system and cirrhosis of the liver all exhibit significantly low SMR's. If these causes are truly low, this could of course be a factor in the excess of cancer deaths in a proportional analysis. Arteriosclerotic heart diseases, emphysema, and external causes are all significantly high. At least part of the arteriosclerotic heart disease excess may be due to a coding change between the 7th and 8th revisions.

Nearly all the excess emphysema deaths occur for those dying over 65 years of age. Standard mortality ratios are especially high for those with an early initial year of employment and for chemical operators, power operators, and other craftsmen. These occupations are those which also exhibit high standard mortality ratios for lung cancer. Possibly this says something about the smoking habits and/or occupational exposures of men in these categories. Possibly also the dust in the region is a factor.

Table 2

Standard Mortality Ratios by Occupation and Dose

Sub-Group By Occupation	No. in Group	% With "High Doses"[1]	Cancer	of Colon	of Pancreas	of Lung	Lympho-sarcoma	Other Lymphatic	AHD[2]	Emphysema	Motor Vehicle Accidents	
Reactor & Pile Op.	30	66.7	1.07						1.12			
Radiation Monitors	12	41.7	.95						.73			
Millwrights	53	28.3	.88	1.12	1.66	.64	.00	.00	1.37*	1.04	3.60*	.
Chemical Op.	57	26.3	1.76**	2.32	3.42	1.70	6.35	.00	.98	3.98	.87	1.
Steamfitters	59	25.4	1.83**	2.02	3.12	1.24	6.71	5.08	1.13	.00	.63	.
Metal Workers	23	4.3	1.57						1.15			
Other Operators	69	1.5	1.20	1.85	2.99	.00	6.64	.00	1.38**	.00	.91	1.
Power Operators	142	0.0	1.36	.00	1.32	1.38	.00	4.63	1.00	1.79	2.13*	.
Other Craftsmen	254	3.9	1.20	.71	.74	1.57*	.78	1.25	1.26**	1.68	1,22	1.
Total Dose 10 Yrs. Prior to Death	(for those with 5 or more years at Hanford)											
0 -	440		.93	.87	.45	.91	.91	1.48	1.13	1.24	1.42	1.
.12 -	364		1.24*	1.63	1.78	1.32	2.21	1.72	1.04	1.92*	1.55	1.
.49 -	231		1.23	1.74	1.90	1.20	.00	2.59	1.25**	1.10	1.44	.
1.18 -	97		.97	1.22	1.82	1.22	.00	.00	1.09	2.23	.81	1.
2.14 -	114		1.27	2.02	1.52	1.00	3.34	7.83*	1.01	1.70	1.96	1.

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* Significantly different from 1.0 at the .05 level

** Significantly different from 1.0 at the .01 level

[1] The "high dose" category is defined as those with a total dose of 2.14 rems or more 10 years prior to death.

[2] Arteriosclerotic Heart Disease (primarily heart attacks)

Mr. ROGERS. Thank you very much, Dr. Milham, for a very effective statement. Dr. Carter?

Mr. CARTER. Thank you, Mr. Chairman.

Did the AEC keep you from publishing your study for a time?

Dr. MILHAM. No, it was my decision not to publish.

Mr. CARTER. It was your decision?

Dr. MILHAM. Right.

Mr. CARTER. why did you make this decision?

Dr. MILHAM. I had a number of reasons. No. 1, it was a very sensitive issue at the time. The study I did, the occupatinal mortality study, pinpointed a number of other industries with problems, and once I had learned that the proper followup study was indeed in the works, it was being done, I didn't see any point in—I was worried about lack of continuity. I was afraid if it did get out in the literature it might cause problems for the current contractors.

Mr. CARTER. You were waiting for a project of greater scope to be made. is that right?

Dr. MILHAM. Right. I didn't have any radiation data. My ideas were conjectural. I knew about excess cancer, but I did not know why.

Mr. CARTER. But there is no doubt in your mind that there was excess cancer found among the workers there at Hanford?

Dr. MILHAM. I was convinced. my study showed that to my satisfaction.

Mr. CARTER. Thank you very kindly.

Mr. ROGERS. Mr. Walgren?

Mr. WALGREN. Dr. Milham, in your statement you indicate that the AEC and ERDA commissioned an evaluation of your findings by Battelle Northwest Laboratories conducted by Ethel Gilbert, and you say in your statement the evaluation of your study supported your findings.

Dr. MILHAM. That is my interpretation.

Mr. WALGREN. You say the evaluation supports my initial findings in great detail and, more importantly, suggested to you a positive cancer/radiation exposure relationship. These, however, are not the same conclusions reached by the author of the evaluation.

Can you develop that for us?

Dr. MILHAM. You will have Dr. Gilbert to question yourself, but the words of her document didn't seem to me to agree with what I could read in her tables, so I thought that her basic conclusion was that there was no radiation relationship with this excess mortality, but when I look at her tables I see a radiation relationship.

Mr. WALGREN. Would that be obvious to members of the committee, too, if they were to look at the table? Would they be able to see a radiation relationship?

Dr. MILHAM. I think with guidance.

Mr. WALGREN. Could you briefly give us that guidance?

Dr. MILHAM. It is the last piece of paper in this stack, table 2. The numbers on the right side of the table are standardized mortality ratios. They should be one if there is no mortality excess. If you look along chemical operators and steamfitters, under these cancers you see standard mortality ratios in the neighborhood of three, six, and five. Six means there is a six time excess; the ratio between the observed and expected deaths is six.

You see, there is excess SMR's for cancers in those columns. The other thing I would like to call your attention to is that the highest SMR's are in those occupations with percent high doses, the second column. That is radiation dose. The bottom part of the table says, total dose, 10 years prior to death.

I call your attention to the fact that most of the high SMR's are in the high radiation groups. The highest one is in the highest radiation group, and the others are in the higher groups. In the zero dose groups, there are essentially no high SMR's. Does that make sense?

Mr. **WALGREN.** Yes. Not to belabor the point, the SMR's, the standard mortality ratios——

Dr. **MILHAM.** The ratio of observed deaths to expected deaths. When you get more observed than expected, the ratio goes above one, you see, and the higher it gets above one, the greater the ratio of observed to expected deaths.

Mr. **WALGREN.** I see. Perhaps at this point in the record it would be helpful to have a brief evaluation by you of these statistics, and we can hold that open, and you could submit just a comment on that if you would like, if you feel it would clarify your disagreement with Ethel Gilbert.

Dr. **MILHAM.** I think the issue will be clarified in subsequent testimony.

Mr. **WALGREN.** I wanted to just ask you, then, to elaborate on your feelings that the responsibility for carrying out future studies should not reside in ERDA or among ERDA contractors.

Dr. **MILHAM.** To quote a colloquialism, it is like the fox watching the chicken coop.

Mr. **WALGREN.** Is that because they have an interest in the outcome?

Dr. **MILHAM.** The people there are sincere. I know them. They are friends. I think they are good scientists, but their visibility and credibility, unless they have supervision from, say, an outside, independent committee of some sort, would be suspect. In other words, company doctors work for the company, in my experience, and I do have a lot of experience in occupational medicine, and it is important who pays your pay, who gives you your paycheck.

I am not saying that these people are biased or doing bad work. I think they are credible people, and I am cooperating with them in every way I can, but I think it would be best to address the issue as dispassionately and unbiasedly as possible, and there is an issue.

Mr. **WALGREN.** Thank you, Mr. Chairman.

Mr. **ROGERS.** With whom did you talk at the AEC? You said you talked with AEC people, and got the impression there that the release of your findings might cause concern and problems in the industry.

Dr. **MILHAM.** That was a long time ago.

Mr. **ROGERS.** Do you recall when that was?

Dr. **MILHAM.** I recall the plant manager was there, and some of his staff. The atmosphere was sort of like a funeral, quiet, no smiles. This is serious business, and I recognized it as such, but they were polite to me, and opened the door, and said nothing about withholding publication. After I got back, I got to thinking, maybe it would be best if I did not. I went to the trouble of writing a paper, which I don't ordinarily do unless I intend to publish it, but after I had been there, I got to thinking politically, and for a lot of reasons, it would probably be better in the long run not to publish it then.

There were a lot of nuclear initiatives before various State legislatures, and there was a lot of sensationalism, and I wanted to keep things quiet, and get the right followup studies done.

Mr. ROGERS. You said you were given the impression at this meeting that there might be problems if your report was made public.

Dr. MILHAM. Right. Maybe not in so many words, but I got the feeling definitely.

Mr. ROGERS. Let me ask you about the statistics of the Gilbert study. Do they differ from yours in any great regard?

Dr. MILHAM. You have to understand , I don't have any radiation data whatsoever. My study is a proportionate mortality ratio study. No; I think there is basic agreement.

Mr. ROGERS. With what you found and———

Dr. MILHAM. With what I found, My basic data, looking at the same 700 deaths, I think they found basically the same thing.

Mr. ROGERS. Were you aware of the Mancuso findings at about that time? I notice you talked to Dr. Sanders, who was the statistician.

Dr. MILHAM. I talked to Dr. Mancuso also on the telephone. He set up the meeting for me.

Mr. ROGERS. How did your study compare with Dr. Mancuso's?

Dr. MILHAM. I think I was a little bit ahead of them. You see, their study requires them to go to the Social Security Administration to get deaths. I actually work in the same building where the deaths come, so I was ahead of them in terms of years of death. In other words, I had more recent deaths.

The other big difference with their study was that I used the Washington State deaths for a comparison population, but after I saw the basic data they were collecting, I was impressed, frankly, that this was going to tell the story in time, and I happened to have a head start on them because of where I sat with the death records, but I didn't want to disturb the continuity of the study. That is the main reason I withheld publication.

Mr. ROGERS. And you were employed, then, by whom?

Dr. MILHAM. Washington State Health Department.

Mr. ROGERS. So you were in no way employed by AEC or any Federal Government agency?

Dr. MILHAM. I worked for the State of Washington.

Mr. ROGERS. Have you done any further studies?

Dr. MILHAM. Well, that one study, the big one, showed a number of occupations with problems, and I have been engaged since in followup studies in a number of other occupational standards.

Mr. ROGERS. What have you found there?

Dr. MILHAM. The basic findings of that study are supported chapter and verse. When we get into the other industries that we found problems with initially, we find that the study was right.

Mr. Rogers. In other words, other occupational classifications in the nuclear industry?

Dr. Milham. These are non-nuclear industries.

Mr. Rogers. But did these involve exposure to radiation?

Dr. Milham. Exposure to other chemicals basically. I have done no more work with the Hanford file except that we are in the process of updating the basic data. You see, I have no access to the basic worker data at Hanford.

Mr. Rogers. Have you requested the data?

Dr. Milham. Not formally, but I have informal relationships with people doing the studies.

Mr. Rogers. What has been the response?

Dr. Milham. Basic cooperation.

Mr. Rogers. So you can get the records?

Dr. Milham. I have not put then to the test of getting the basic data, but I think I probably can.

Mr. Rogers. Have you seen the current Mancuso report showing significant cancer risks from radiation exposure?

Dr. Milham. Yes, I have.

Mr. Rogers. What is your opinion of that report?

Dr. Milham. I think it vindicates my initial work. I think it supports it.

Mr. Rogers. Then you are in agreement——

Dr. Milham. Yes, I am. yes, I am.

Mr. Rogers [continuing]. With the finding of the Mancuso report?

[Dr. Milham nods affirmatively.]

Mr. Rogers. And I understand that you feel that studies should not reside with the agency that is also causing the problem. I believe that was your position.

Dr. Milham. Well, I did not say it that way.

Mr. Rogers. Well, I understand. You used what, the fox and the chicken coop?

Dr. Milham. The fox and the chicken coop.

Mr. Rogers. Well, I guess we all understand that.

Thank you so much. Oh, excuse me. Dr. Carter may have a question.

Mr. Carter. In your table, I notice in three instances that you have an incidence of lymphosarcoma more than six times as common among these workers than the average. Is that correct?

Dr. Milham. That is Dr. Gilbert's table, but that is how I read that. Those are probably based on small numbers. Still, the SMR's are above six in the lymphosarcoma column for chemical operators, steamfitters, and other operators.

Mr. Carter. How did you get involved in this Hanford study?

Dr. Milham. Well, I work for the State of Washington, and the death certificates contain an occupational statement, and no one in the State has used this statement, so what I wanted to do is find out, if you look at cause of death and occupation, how are they related, and it happened that Hanford was one of the industries we looked at. We looked at every industry, carpenters, farmers, copper smelters, aluminum mills, and this is just one of the ones that fell out as having more cancer.

Mr. CARTER. Did you find the incidence of cancer as high in any other occupation?

Dr. MILHAM. As high? Yes, yes.

Mr. CARTER. In other industries?

Dr. MILHAM. Higher.

Mr. CARTER. Which ones?

Dr. MILHAM. Copper smelters have a lot more lung cancer, for example. Aluminum refiners have pancreatic cancer, lung cancer. I could go on for half an hour.

Mr. CARTER. Were you on contract?

Dr. MILHAM. To whom?

Mr. CARTER. To anyone at this time?

Dr. MILHAM. Now?

Mr. CARTER. At the time you did this study.

Dr. MILHAM. No; I worked for the State of Washington as a salaried physician.

Mr. CARTER. And your initial funding was, of course, from them?

Dr. MILHAM. Right, and when I collected all my basic data, I went to NIOSH, the National Institute of Occupational Safety and Health, and said I could use some money to analyze the data. I had it all on tape, ready to go, and they paid me an amount to analyze it. They subsequently published the report appended here. I have the front cover xeroxed.

Mr. CARTER. Thank you very kindly, Mr. Chairman.

Mr. ROGERS. Let me ask this, and I will conclude. Did you make the AEC officials that you visited with aware of your study and the findings of your report?

Dr. MILHAM. Right.

Mr. ROGERS. Did they take any action as a result, that you are aware of?

Dr. MILHAM. I really do not know what they did. They had no communication with me except a couple of years later. I don't know what they did. They must have taken some action. They commissioned this work by Battelle to review my findings. I know that for sure.

Mr. WALGREN. If I might, so the action the AEC took was to study your findings and come up with the conclusion you were wrong?

Dr. MILHAM. I don't know that I would conclude necessarily that I was wrong. That was not my conclusion when I read these. I was sort of amused. I would read these and say, boy, it makes my stuff look better and better all the time.

Mr. WALGREN. But the problem is, to the trained eye, it makes your stuff look better and better all the time, and when you look at the statistics, apparently, it does, but when you look at the text surrounding that is perceived by the general public, they are issuing conclusions that there are no dangers here.

Dr. MILHAM. I do not know that these were ever generally released. I think these were sort of in-house documents or reports. Maybe they got out, but they were sent to me by Dr. Mancuso.

Mr. WALGREN. So they were in-house reports in the agency that was responsible for setting the standards of exposure at the time?

Dr. MILHAM. I guess, yes.

Mr. **Walgren**. One of the great difficulties I have with everyone that comes before us, and this includes the Army personnel who were responding to requests to track the people who had been exposed in the nuclear blasts and the like, it is as if they do not take it seriously, and they are the ones involved in setting the standards of exposure for military personnel.

Dr. **Milham**. I think they took me very seriously. I think that they took me super-seriously. The way I saw it, they said, well, is this stuff for real? Let's find out. I don't know what their conclusions are now, but I was taken seriously, I assure you. I was not laughed off.

Mr. **Walgren**. But then when the report was made, the conclusion was whatever Ethel Gilbert at the Battelle Laboratories concluded, that this is apparently nothing to be concerned about.

Dr. **Milham**. I don't really want to put words in anyone else's mouth. The way I interpreted it was that Milham might have something here, but based on the numbers, et cetera, it probably does not show a striking radiation relationship. You have to realize that her analysis was three or four years ago now. They may have different conclusions now. I don't know.

Mr. **Walgren**. Thank you, Mr. Chairman.

Mr. **Rogers**. But you are not aware of any action taken by the AEC, as far as you know, to alert workers to dangers as a result of your study?

Dr. **Milham**. I don't think that is really appropriate at this point in time, but I don't believe they have.

Mr. **Rogers**. Has there been any request from any of the agencies that you continue your studies to get the actual records and either confirm or deny the death statistics that you found and the conclusions drawn?

Dr. **Milham**. Requests by whom?

Mr. **Rogers**. I wonder about the AEC, ERDA, DOE.

Dr. **Milham**. I have had some requests made of me for the basic records, and I have furnished death certificate copies to the AEC contractor, Dr. Mancuso, and I am continuing a collaboration with Battelle and Hanford environmental health people. I am talking to these people. I intend to help in any way I can. They have the basic worker data and the basic followup study.

Mr. **Rogers**. And these are simply not in your possession.

Dr. **Milham**. Not in my possession, no.

Mr. **Rogers**. Thank you so much for helping us, Doctor. Do you plan to be here today?

Dr. **Milham**. Today and tomorrow.

Mr. **Rogers**. I think it would be helpful if you can, because we may want to call you back.

Dr. **Milham**. I will be here.

Mr. **Rogers**. And if you can listen to the testimony as it develops, I think it will be helpful.

Dr. **Milham**. I will be here.

Mr. **Rogers**. Thank you.

The next witness will be Dr. Thomas F. Mancuso, Department of Industrial Environmental Health Sciences, Graduate School of Public Health, University of Pittsburgh. He is accompanied by Dr. Alice Stewart and Mr. George Kneale.

If you would like to take a place at the table, we would be pleased to have you. We welcome each of you to the committee, and I am going to call on Mr. Walgren to make an introduction.

Mr. WALGREN. I just want to take the opportunity to welcome you to the committee, Dr. Mancuso, and to introduce you to the committee. As a Member of Congress from the Pittsburgh area, I am particularly pleased to have you here in Washington, and especially on this subject.

Dr. Mancuso is a research professor of occupational health at the Graduate School of Public Health of the University of Pittsburgh. He has spent a lifetime in the research of occupational disease and occupational hazards, has written widely, is the author of a number of articles in the various professional journals. He is a medical physician, as well as the holder of a graduate degree in public health.

We are very happy you are here, Dr. Mancuso.

Dr. MANCUSO. Thank you, Congressman.

Mr. ROGERS. We welcome you, along with our distinguished colleague. Perhaps you would like to identify and say a word about your colleagues at the table.

STATEMENT OF THOMAS F. MANCUSO, M.D., RESEARCH PROFESSOR, DEPARTMENT OF INDUSTRIAL ENVIRONMENTAL HEALTH SCIENCES, GRADUATE SCHOOL OF PUBLIC HEALTH, UNIVERSITY OF PITTSBURGH, ACCOMPANIED BY ALICE STEWART, M.D., EPIDEMIOLOGIST, AND GEORGE KNEALE

Dr. MANCUSO. I am Dr. Mancuso. The colleague on my left is Dr. Alice Stewart, a distinguished scientist from England, and my colleague on the right is Mr. George Kneale, a distinguished statistician from England, both of whom have pioneered and worked in the field of low-level ionizing radiation, and have conducted pioneering studies for many years relative to the effects of radiation in low doses.

Mr. ROGERS. We welcome you to the committee.

Dr. MANCUSO. I am very grateful that I have had them as my principal consultants during the last year of my contract at the University of Pittsburgh, and it has been their remarkable ability that has made it possible to detect the cancers using such a small population base.

For the purposes of the committee at this time, I have made available to you a detailed document which provides the chronological history of the study, and sequence of events, together with various attachments [see p. 527].

I think at this time because of the number of witnesses who will appear before you, that I will be very brief relative to my comments. I will comfine myself with an overview of the situation, so that as many questions as deemed possible can be asked of me and my associates.

Briefly, in 1964, the representatives of the staff of the Division of Biology and Medicine of the Atomic Energy Commission came to me at the University of Pittsburgh and asked me whether I would be willing to undertake a feasibility study to determine whether the records that existed in the various AEC contractor facilities would lend themselves to answer a basic question, that is, whether there was or not any effects relative to low-level ionizing radiation.

My task in that first year was to make a study of approximately 14 different AED contractor facilities in the United States to ascertain the feasibility of this, and at the conclusion of the first year, I did determine and did recommend that it would be possible to conduct the type of study which we now are here presenting.

Subsequent to that, in 1965, I was given a 5 year research contract, and then it was renewed each year as each progress report was submitted. A notification was then made to the University of Pittsburgh, on January 16, 1976, that the project would be terminated. I had previously been informed informally in March of 1975 that the project would be terminated.

During the years between 1964 and 1975 on, those years were used to develop and organize a tremendous amount of data involving millions of bits of data at each of these various facilities, and try to collate them and develop a system which could then be used for this particular study. A basic problem in the study of occupational cancer is the fact that there is a long latent period in which several decades may pass before the occupational cancer may be detected. I mention that because this is apropos of a comment I am going to make later on relative to a point that was made to me about my reluctance to publish data.

In the methodology I designed, I used the social security approach. The particular advantage of the study was the fact that I was able to use the intervening years which had elapsed since 1944 to the time at which I began the study and started to collate the data in 1965. In other words, approximately 20 years had already elapsed, and with the additional time that has occurred now, in 1976 and 1977, of course, the interval of time is now reaching the point where we could begin to detect occupational cancers.

This is in contrast to the idea, for example, that if you wanted to answer the basic question about what are the effects of low-level ionization radiation, you institute a study now. Then for this population identified throughout the United States we will now begin to badge each one of them, each week or each month and each year, and collect the data, and we will know the answer 40 years from now.

So, in effect, the design of the study was most fortuitous, and we have now reached the stage of the critical analysis of our data. A key point Dr. Sam Milham had mentioned to you was the fact that in the summer of 1974—and this is part of the linkage of the sequence of events—Dr. Sam Milham had made this unique observation. In studying the occupations on the death certificates and relating them to prior employers, he found out that the individuals who had previous employment in the Hanford atomic facility showed a much greater excess of cancer, as he so stated. This is a point in a sequence of events.

It was at that time, in the summer of 1974, when there was a tremendous amount of activity. Although Dr. Sam Milham may not be aware of it, I was aware of it. I was on the telephone by the hour relative to communications from Hanford and from the AEC headquarters, who were very much concerned about the impact on the public should there by any release of Dr. Sam Milham's findings.

They were very concerned about my reaction to what might occur and what should be said or could be said relative to the press, should the press query me on this particular problem.

During the course of the years, as I have stated in my final report, No. 13, I have been repeatedly urged by AEC and ERDA to publish the negative progress reports. I refused to publish prematurely in view of the long latency period of cancer and the continued problems of developing the data. Any analysis which did not meet the number of years required to induce the occupational cancer would lead to false negative findings that would be misleading and could be misused. Consequently, during the course of that summer of 1974, a recommended press release was dictated to me by one of the staff members of the AEC, to counteract the positive findings that Dr. Sam Milham had come up with by citing the negative findings that were occurring in our progress reports.

The sequence of events then occurs with a letter that Dr. Karl Z. Morgan wrote on May 25. Dr. Karl Z. Morgan, professor of nuclear energy of the Georgia Institute of Technology, wrote a letter to Secretary Schlesinger, and in that letter, Dr. Morgan expressed concern over the termination of the research project relative to low-level ionizing radiation, and felt that this would be at a very great cost and represent serious discontinuity of effort.

The letter was referred to Dr. J. Liverman for reply, and Dr. J. Liverman, in his letter, said in effect that his staff got together with him in the summer of 1974 and made certain recommendations to him in view of Dr. Mancuso's "imminent retirement," and I just want to point out to you that I was 62 in the summer of 1974, and was not consulted in the summer of 1974 relative to the inhouse deliberations. I could continue at the age of 70 at the University of Pittsburgh as long as research funds were available. There was no mention in Dr. Liverman's letter to Dr. K. Z. Morgan about the cancer findings that Dr. Milham had noted.

I feel there is a direct correlation relative to the time period, relative to the summer of 1974. First, the great concern with Dr. Milham's positive cancer findings among the former Hanford workers occurred, and then the decision, according to Dr. Liverman, in 1974, that I was about to have an imminent retirement at age 62, which was immediately followed by a clear-cut expression and desire to transfer the project to the Oak Ridge Associated Universities at a time when there was a major scaling down of the clinical program at that facility, and therefore a major need of funds and continued financial support for succeeding years was made possible.

This combination of events leads me to believe that the imminent retirement reason was created and used as a convenient excuse and means for taking away the independent status of the study, which had been in existence since 1964 at the University of Pittsburgh.

However, the ERDA staff evidently discovered subsequently that the administrative decision in the summer of 1974 to retire me at the age of 62, that I was about to have an imminent retirement, was not holding up very well, and since then ERDA has advanced and put forward a series of news releases and statements of adverse peer reviews, citing a January 8, 1976 memorandum which was 1½ years after the decision made by Dr. Liverman of imminent retirement, and I will discuss those as the session goes on.

In the January 8, 1976, peer review which I obtained fortuitously by someone who had asked ERDA what was the reason for transfer of the project from Dr. Mancuso, the statement came back with a memorandum, January 8, 1976. They did not state at that time that Dr. Liverman had already made the decision in the summer of 1974 relative to imminent retirement.

There are several points relative to the document which I do not accept. One, they say that ERDA accepted as a reason for termination of the contract my desire to expand the project. This has no validity at all, because not only is ERDA enlarging the population itself, but the prior AEC consultants had recommended that the project be enlarged.

Then, I will discuss with you as time goes on the fact that I refused to publish prematurely and the reasons for that; further, there was a statement relative to the fact in the report that Dr. Mancuso's inclination is to achieve something approaching perfection in the quality of the data before starting analysis. This is not a feasible modus operandi. I do not accept that criticism at all. I think trying to obtain the highest standards in data collection is the basic ingredient of a research investigator.

Finally, there is one other statement in that memorandum on the quality of statistical analysis. All I say, in fact, is, at no time did the ERDA representatives ever send me a memorandum which said, in effect, that your project was in jeopardy because you did not have the proper statistical help. I had already indicated that I was about to seek additional help. Also, there was no reluctance on the part of ERDA to utilize the negative reports. They did not ever raise the question of questionable statistical quality of the data at the time that they were recommending that I publish the negative findings.

I would be very happy to answer questions. I would like at the appropriate point in time to ask Dr. Alice Stewart, assisted by Mr. George Kneale, to provide the findings of our study. I believe the findings of our study are very important and are critical to this study.

[Testimony resumes on p. 617.]

[Dr. Mancuso's prepared statement and attachments follow:]

STATEMENT OF
Thomas F. Mancuso, M.D.
Research Professor
Department of Industrial Environmental
Health Sciences
Graduate School of Public Health
University of Pittsburgh
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My purpose as the Principal Investigator of the research project, "Study of the Life Time Health and Mortality Experience of Employees of AEC Contractors", is to provide a chronological development of facts relative to the consideration which led to the termination of the research project at the University of Pittsburgh and the change to the Oak Ridge Associated Universities.

The progress reports are available; they begin in 1965 and continue to the final report #13 for the last period of the contract (August 1, 1976 to July 31, 1977). A comprehensive presentation in a single volume, (186 pages), including the historical development of the AEC study, the plans, methodology and preliminary findings constitute Volume III of the Health Physics Society Annual meeting, November 1971.

On May 25, 1977, Dr. Karl Z. Morgan, Neely Professor, School of Nuclear Engineering, Georgia Institute of Technology wrote a letter to Mr. James Schlesinger, Executive Office of the President, Energy Policy and Planning. In that letter, Dr. Karl Z. Morgan, refers to: 1) major consequences of certain policies of the past "even studies relating to such important questions as brittle fracture of the reactor containment vessel, common mode failure and emergency core cooling were suppressed, the findings depreciated and not published".

2) Concern over the termination of the Mancuso program ("to which I am a consultant") "this change would be at a very great cost and would represent a serious discontinuity of effort".

"Perhaps at this stage there is something you can do to prevent this transition".

"Surely it is a conflict of interest for this program to be conducted in Oak Ridge under contract with either ERDA or NRC".

The letter to Secretary Schlesinger from Dr. K. Z. Morgan was referred to Dr. J. Liverman. On September 8, 1977 Dr. J. Liverman wrote to Dr. K. Z. Morgan and stated "In the Summer of 1974, my staff came to me with the question of what disposition should be made of the materials being used by Dr. Mancuso, following Dr. Mancuso's imminent retirement. "I asked for and received a memorandum dated December 2, 1974. After study and deliberation the staff recommended that the studies be continued and enlarged under the auspices of the Oak Ridge Associated Universities (ORAU) with the continued participation of Dr. Mancuso (as consultant) if he chose to join the study after his retirement... I approved the recommendation with the proviso that Dr. Mancuso be informed of both parts of the decision (a) the study would be moved because of his imminent retirement..."

(I was 62 in the Summer of 1974 and was not consulted in the Summer of 1974, relative to the inhouse deliberations. I could continue to age 70 at the University of Pittsburgh as long as research funds were available.)

A quotation from a news account reported by William Hines of Chicago-Sun Times, November 13, 1977 is as follows: "Last week an Energy Department Spokeman, Phil Garon said he "had always heard that Mancuso's retirement was the reason for moving the project to Oak Ridge". "Liverman authorized Garon to state in his name that while "I personally do not know the retirement policies of the University of Pittsburgh" he accepted a staff recommendation for transfer of the project so that the project could be continued and eventually expand". [In the D.O.E. transcript of a telephone interview on November 8, 1976 the question from Bill Hines, Chicago-Sun Times was "How did Dr. Liverman get the idea that Dr. Mancuso's retirement was imminent" (as Liverman stated in his letter to Dr. K. Z. Morgan); [Dr. Liverman's reply "my staff advised me in the Summer of 1974 that Dr. Mancuso's retirement was drawing near. I personally do not know the retirement policies of the University of Pittsburgh"].

It does appear that Dr. J. Liverman and his staff in discussing the research project in the "Summer of 1974", in which they made the decision to transfer the project "because of Dr. Mancuso's imminent retirement", left out of their decision making process an essential fact, that a telephone call or letter to the University of Pittsburgh (which was also not done) would have informed them that I could continue to the age of 70 with my own research funds.

This reluctance in the decision making process to make such a single direct inquiry on my behalf in the Summer of 1974, raises questions as to the fairness of the decision and whether in the Summer of 1974, there were other reasons for the transfer of the project.

There was no mention by Dr. J. Liverman in his letter of September 8, 1977 to Dr. K. Z. Morgan, that in the Summer of 1974 that Dr. J. Liverman and his staff knew at that period of time, that Dr. S. Milham, Epidemiologist for the State of Washington, had discovered an excess of cancer deaths among former Hanford Atomic workers and that the staff of AEC-ERDA were very much concerned about the adverse effect of the release of such findings on their public position of no harmful effects.

I noted a temendous flurry of activities from AEC and Hanford operations during that period of time in 1974. I was called from Hanford and AEC and was on the phone by the hour over a period of weeks. I was being called because Hanford and AEC feared public knowledge of the Milham findings pertaining to the cancer deaths among the Hanford employees. They wanted to be ready with their response in form of press releases, to refute the findings through our currently negative results. The major concern of the AEC at that period of time in 1974 was with the Milham findings of cancer and its impact on the public and the AEC program.

AEC - was concerned about my possible reaction should the "press" make inquiries about the positive cancer findings found by Dr. Samuel Milham in the State of Washington, where the Hanford Atomic Facility was located.

As evidence of this concern the attached enclosure (1) is an AEC recommended press release dictated by Dr. Sidney Marks (AEC Headquarters), to me as recorded by my secretary.

The AEC press release cites the negative findings of the Progress Reports (at that time) of the AEC research study as a means of counter acting the positive cancer findings identified by Dr. S. Milham of the deceased former Hanford Atomic workers.

I recall telling Dr. Sidney Marks (AEC) at that time on the phone, that there were two reasons why Dr. Milham could have found the positive cancer findings in contrast to our current negative progress report. This was that the deaths, in the Milham study, covered a longer time period. (This provided a longer period of observation which is critical in cancer studies). Further that the Milham study, included the deaths from the Atchinson Jones Maintenance group, that serviced the nuclear reactors, which were not part of the AEC study. (I had previously identified that maintenance group as an important group of employees, to include in the AEC study because they were acknoledged to have more radiation exposure than the workers. They were not part of the AEC study at that time, although repeated recommendations had been made for their inclusion in previous years).

As stated in the introduction to the final report #13 I had been repeatedly urged by AEC-ERDA to publish the "negative" progress reports. I refused to publish prematurely, in veiw of the long-latent period for occupational cancer and the continued problems of developing the data. Any analysis which did not meet the number of years required to induce the occupational cancer, would lead to false negative findings and would be misleading and could be misused.

Consequently, the essence of the recommended press release as prepared by the AEC to counter the positive findings by Dr. Sam Milham, by the use of my then negative progress reports was inappropriate and would have been misleading to the public.

Within this context, the 1/8/76 ERDA memorandum[2] (obtained under the Freedom of Information Act) cites the "questionable statistical analysis" of the prior years, in the AEC research progess reports. This recognition did not deter the AEC-ERDA from uring me to publish the then negative progress reports during those prior years.

It is also evident that Dr. Sidney Marks did not refer to or cite the "questionable quality of the early statistical analysis" in the recommended press releae that he dictated to me, in which Dr. S. Marks cites the negative findings of the AEC research study at that time as a means of counter acting the positive cancer dindings identified by Dr. S. Milham of the deceased former Hanford Atomic workers. The implications are that the AEC-ERDA staff did not object to citing the then negative findings of the progress reports to serve their own purposes.

In Dr. J. Liverman's (September 8, 1977) letter to Dr. K. Z. Morgan, he stated relative to the Summer of 1974, "after study and deliberation, the staff recommended that the studies be continued and enlarged under the auspices of the Oak Ridge Associated Universities". (Emphasis added).

On Page 4 of the 1/8/76 memorandum, the section under ERDA plans for the Health and Mortality Study states as follows:

"In 1974, at the time of a major scaling down of the clinical program at ORAU, plans for enlargement of the Oak Ridge Associated Universities activities in the area of human studies were developed. The possible assumption of responsibility for the health and mortality study was included among the projects to be considered for the development at ORAU. Since then the ORAU medical division has been informed that, if they developed the necessary expertise, the Health and Mortality Study will be transferred to ORAU is to be phased in during the last year of Dr. Mancuso's contract which would begin on August 1, 1976". (Emphasis added).

Since the 1/8/76 memorandum refers to the development of "expertise" at ORAU, it does seem most unusual that a project of this importance at this critical stage of analysis should be changed from the principal investigator who organized and developed the data, to a new group (to be developed) and organization. The question is why the change from a principal investigator that developed the data, at this critical stage of the analysis to another organization?

There appears to be a definite correlation relative to the time-period "during the Summer of 1974". First, the great concern with the Dr. Milham's positive cancer findings among former Hanford Atomic Workers occurred. Then the decision according to Dr. J. Liverman made in the Summer of 1974, that Dr. Mancuso was about to have an "imminent retirement" (age 62); this was immediately followed with the clear cut expression and desire to transfer the research project to Oak Ridge Associated Universities, at a time when there was a "major scaling down of the clinical program at ORAU" and, therefore, a major need for funds and continued financial support for succeeding years was made possible.

It is evident too that the deliberations on the selection of either Oak Ridge National Laboratory and the Oak Ridge Associated Universities was in the Summer of 1974 and therefore the memorandum of December 2, 1974 and the preceeding staff notes and records prior to the Summer of 1974 should be made available, which related to the observation of the Milham cancer findings, and the expression of the decision to transfer the project as stated in the December 2, 1974 memorandum

Subsequent to the Summer of 1974, because of Dr. Milham's positive cancer findings, ERDA, made rapid arrangements for Battelle Northwest in Richland, Washington to conduct an analysis of the Hanford data in an intended effort to discredit the Milham cancer findings. The subsequent Gilbert report from Battelle Northwest did come up with a negative conclusion. However, when the report was reviewed by other statisticians, it was determined that the analyses actually revealed a positive cancer correlation directly related to radiation dose, which confirmed Milham's cancer observations of 1974.

In my opinion, the positve excess cancer finding by Dr. S. Milham identified in the Summer of 1974, was in turn translated into a desire and plan by AEC-ERDA to control the data and the project through the Oak Ridge Associated Universities, as well as Battelle Northwest and the Los Alamos project, and at the same time fulfill a need of support for the Oak Ridge Associated Universities because of the major decline in support for that organization.

This combination of events leads to the belief that the "imminent retirement" reason was created and used as a convenient excuse and means to take away the independent status of the study which was in existence since 1964 at the University of Pittsburgh under my direction, and to ensure the control of the data at their discretion in the critical stage of the analyses in the years ahead.

However, the ERDA staff subsequently discovered that the administrative decision in the Summer of 1974 to arbitrarily retire me at the age of 62, could be seriously questioned. Since then ERDA has advanced and put forward the concept of adverse peer reviews citing a 1/8/76 memorandum which was 1-1/2 years later after the decision of imminent retirement already had been stipulated by Dr. J. Liverman.

This is in contrast to the statements made by Dr. J. Liverman (9/8/76) to Dr. K. Z. Morgan. In this letter-reply, at the request of Secretary Schlesinger, Dr. J. Liverman clearly and definitely stated that the reason for the transfer of the project was "imminent retirement". There is no mention in that letter, that the reason in anyway was related to poor performance.

However, in a letter (8/11/77) to Mr. John Ahearne of the Executive Office of the President, Mr. J. Liverman stated in explanation:

"The recommendation to transfer the project from the University of Pittsburgh to the Oak Ridge Associated Universities rather than the Oak Ridge National Laboratory, was contained in a memorandum to me dated December 2, 1974. The principal reasons for recommending the transfer of the program were deficiencies in performance under the contract". Dr. Liverman left out in the letter that the reason of "imminent retirement"had already been stipulated in the Summer of 1974.

Since in effect, Dr. Karl Z. Morgan had challenged the transfer that "this would be at a very great cost and would represent a serious discontinuity of scientific effort" it is reasonable to believe that Dr. J. Liverman would have included the reason "deficiencies of performance"(as cited in the letter to Mr. J. F. Ahearne) if that reason had any primary merit or validity. Instead Dr. J. Liverman gave as the reason to Dr. K.Z. Morgan "imminent retirement" with no other explanation.

ERDA STATEMENTS:

At this point, I should like to review the recent statements of "deficiencies of performance" advanced by ERDA and by Dr. Sidney Marks formerly of ERDA, in response to outside requests pertaining to the termination of the research under my direction.

In November 1977, Dr. I. W. Bross made a request to ERDA under the Freedom of Information Act, asking for the reason for the transfer of the research project away from Dr. Mancuso, the Principal Investigator.

The response to Dr. Bross from ERDA was a memorandum dated 1/8/76.[2] The reply made no reference to the fact that Dr. Liverman had decided in the Summer of 1974 to transfer the research, because of "imminent retirement of Dr. Mancuso". This memorandum was forwarded by Dr. I. Bross to me. I had never seen the memorandum prior to that time and was never provided with any "peer reviews" or any "adverse peer reviews" by AEC or ERDA pertaining to this research project since 1964.

Since in each of all the previous years from 1964 on, the project was funded each year, and since funding is only permitted after careful review of the research project as a prior requirement of funding, then it is reasonable to believe, that the funding would not have been made, if there had been adverse peer reviews of a substantial nature.

Consequently, it would be helpful to determine whether the appropriate approvals of the research contract had actually been made in each of the preceeding years, and further to obtain the documents relating to all "peer reviews" upon which the statement (by Dr. J. Liverman) of "deficiencies of performances" in the letter of 8/11/77 to Mr. J. F. Ahearne is based.

As the principal investigator of this research project since 1964, I do believe I have the right to have the statement of "poor performance under the contract" which was advanced publicly in recent months as a reason for the transfer of the project, clarified and put into proper perspective. The only information I have is the 1/8/76 memorandum and statements in the press.

In the interest of making a distinction between "inhouse reviews" and "outside reviewers" I would like to suggest that all the outside reviewers involved in previous years be identified in order to clarify any prior relationships with AEC or ERDA or other governmental agencies.

The only peer review cited is 1/8/76, which involved only (2) outside reviewers and, therefore, cannot be considered, in my opinion, as an adequate review particularly since only one reviewer recommended that the project be terminated at the University of Pittsburgh and transferred. Secondly, the decision was already made in the Summer of 1974 by Dr. Liverman and the date of 1/8/76 review was 1-1/2 years after that period.

Nevertheless, my purpose is to respond to the ERDA memorandum of 1/8/76, the only one available which was obtained under the Freedom of Information Act. The 1/8/76 memorandum contains certain statements which are in conflict with the facts and others which are misleading, for example:

In the ERDA memorandum of 1/8/76, on Page 2 under "Reviews" the following statements are made:

"Outside review by --------- and --------- both reviewers felt that Dr. Mancuso's call for additional funding and an enlarged study population is not justified. They felt that the expansion of the study would dilute the effort and be counter productive. ---- Recommended that the study be terminated at the end of the current year in July 1976. (Emphasis added) complimented the investigators on their careful meticulous work to date but was critical of Dr. Mancuso's request to enlarge the study. Both reviewers agreed that the study was important and should be continued although ----- recommended that the study be turned over to a different principal investigator".

This is extremely interesting and rather amazing. Because in the early years of this research project the AEC had called in an expert consultant panel, the most distinguished persons they could get and the opinion of this panel of consultants was that the project could not be carried out, unless there was a tremendous increase in the population base. They estimated that we could not detect any leukemia deaths, without a tremendous increase in the study population. The deliberations of that consultant group meeting and their opinions are on file at AEC Headquarters. (Empahsis added).

Consequently, the reason as stated by the two outside reviewers are inconsistent with the review of a much larger scientific reviewer group, selected by AEC before the investment of funds were made in the early stages of the project. Actually, the position of those scientists was that the expenditure of funds could be questioned unless the population of the study group was greatly enlarged!! Their recommendation for enlargement of the study population was consistently included in our progress reports for years.

It is extremely difficult to understand why ERDA then accepted the recommendations of the two outside reviewers, in January 1976 as the basis for terminating the research study, when for years it's much larger panel of AEC consultants scientists had recommended a greatly increased study population.

There is still another ironic twist to this. For years in our progress reports we had recommended inclusion into the study of Rocky Flats (Dow Chemical) in Colorado and the Los Alamos facilities. (There had been considerable concern about potential health problems relative to the Colorado Atomic Energy Facility, and the Los Alamos represented one of the earliest facilities, which would provide observations over a long period of time).

Although the statement is made on 1/8/76 against the expansion of this research project as counter productive which would have included these facilities, by a remarkable coincidence the Los Alamos study was initiated under another name, first called "Health Study of Plutonium Workers" and later, the name was changed to "Health Study of Workers in the Nuclear Industry". I became aware that arrangements were made to include the Rocky Flats Atomic Energy facility in the Los Alamos Study because I had been asked to try to arrange for Social Security to process the data. (Empahsis added).

I was particularly interested in the Rocky Flats Plant, because of the potential health problems. At one time the AEC was going to give me the go-ahead to study that Rocky Flats Plant but the funds never came through. So, years, ago, there was no objection to expanding the project and since both, Los Alamos and the Rocky Flats are being studied now under different auspices, the argument that such inclusions as recommended by me would be counter productive, appears to be inconsistent. (Emphasis added).

Dr. Liverman clearly states the plan to expand the study in his letter to Dr. K. Z. Morgan and certainly his staff knew and the various budgets and correspondence would show the chronological development at ORAU and Los Alamos, in 1974-1975, as well as Battelle Northwest in Richland, Washington.

It is interesting to note that the draft of the protocol relative to the Los Alamos Study is dated January 1976, which means that the arrangements had begun in 1975 with ERDA support. Consequently, ERDA was in the process in 1975 to make other arrangements, in addition to the Oak Ridge arrangements, relative to the conduct of my major research study of the Atomic Energy facilities. This would indicate that the so-called peer review of 1/8/76 really had no bearing on the decision to transfer the project although that was the implied reason given in response to the inquiry under the Freedom of Information Act.

The emphasis in the review that the "call for additional funding and the enlarged study population was not justified and would be counter productive", means that the two outside reviewers were not told by ERDA staff, that ERDA had already planned and set in motion an expansion of the study, as stated by Dr. J. Liverman's letter "in the Summer of 1974" pertaining to Oak Ridge Associated Universities and in the arrangements made with Los Alamos, in 1975 to carry out a "health study of workers in the nuclear industry".

Further, ERDA staff evidently did not tell "both outside reviewers" that the proposal to expand the project had been a consistent recommendation by me for years, to both AEC and ERDA administrations, as shown in the enclosure (3) from one progress report 7/23/70 estimating the costs for processing the data through Social Security, for 10 AEC contractor facilities. The recommendation was presented to AEC to selectively fund some or all facilities. I had strongly recommended inclusion of the Rocky Flats, (Dow Chemical) and Los Alamos, which ERDA is now funding. Evidently, there was no objection by other AEC and ERDA reviewers in previous years to that recommendation of enlarging the study population.

It would be helpful again in developing the necessary background to determine whether these two outside reviewers of the 1/8/76 memorandum were told of these prior arrangements. It would be helpful if they would be interviewed. If they knew, then the basis of using the argument that expansion of the project would be counter productive as a reason for terminating the project was not valid. Conversely, if the two outside reviewers did not know, then ERDA was accepting a reason to terminate the project, which they themselves already knew was not valid.

Further, it is pertinenet to know whether "both outside reviewers" had been told by ERDA staff, that prior AEC consultants, years earlier had recommended that the research project be expanded to enlarge the study population base and that this was essential in the conduct of the study.

If both reviewers knew that such prior AEC consultant reviewers had already clearly specified that the AEC study population should be enlarged, then their decision to terminate the project for that reason could be questioned and not accepted.

Similarly, since ERDA staff knew of the prior AEC consultant recommendations on this project, then it was not valid to accept the recommendation for termination of the project because I recommended expansion of the study population.

It is particularly difficult to understand how the ERDA staff did not make this all known to both outside reviewers, or why ERDA would accept that reason (my desire to expand the study population) without providing pertinent information to both outside reviewers, or at least citing in the 1/8/76 memorandum, that certain arrangements had already been made for expansion by ERDA, and that prior AEC consultants recommended such expansion within the context of the memorandum.

The ERDA memorandum of 1/8/76, by these omissions fails to put into proper perspective the events of the prior years and as a consequence misleads anyone who attempts to evaluate or accept that reason as cited in the memorandum.

II.) The statement on Page 3 of the 1/8/76 memorandum: "A second problem as been reluctance by the investigators to publish - He has not as yet published any papers in edited journals at least he could have published the methodology, the plan of the study and some preliminary results". (Emphasis added)

That statement, in my opinion, is misleading since the equivalent of a monograph of 180 or more pages was published in the proceedings of the Health Physcis Society in Richland, Washington 1971, which includes precisely - "the methodology, the plan of the study and some preliminary results".

Actually, special plans were made by me so that all of the 180 pages could be published in one volume - Volume III of the Health Physics Society proceedings and made available to everyone.

It is evident too, that a document of such length could not be published in any other scientific journal. The approach to make the entire description of the nature and scope and preliminary findings of the research project in one large volume, was in actual fact the only approach in which all the information could be presented in one place and time as a single major reference. This was accomplished in November 1971 and was made available to the entire scientific community in this process.

The statement "the reluctance to publish findings" prematurely has already been addressed in my introduction to final report #13. Knowing that occupational cancer may take several decades, I refused to publish prematurely. Any analysis after insuficient years of observation, would lead to false negative findings and be misleading. Concomitantly it took many years to develop and organize the data and both requirements had to be met.

Repeatedly through the years, I had been urged by ERDA to publish in scientific journals, the negative findings of the progress reports, and I refused to do so. I did not accept the excuse tendered that such publication would assist in the renewal of the research contracts. I believed that the findings would be misleading, no matter how well qualified in the presentation and could be misused.

Again, within this context, there is no indication that the two outside reviewers in reference to the statement "lack of scientific publication", were aware or were told of what was involved in the development of the data that went into the research project, nor the dates, the points in time when the data was received by me from the AEC contractors under study, nor the status of such data, and what was subsequently required in the development and applications of such data.

What was not included in the 1/8/76 memorandum was any qualifying explanation of the amount of time in years, that was required to identify, collect, organize and integrate millions of bits of information accumulated over a span of 28 years, in the various AEC facilities, pertaining to employment personnel records and occupations, organization, industrial exposures and radiation records; and the years to develop various systems for each of the data components, integrated at each AEC facility or with each other, which did not exist before; nor the years required to process all the personnel data for the identification of the deceased and the search for the death certificates and the conversion and integration of these data for each individual (35,000 Hanford, 105,000 Oak Ridge) exclusive of the attempted use of siblings and employee controls, and study of other facilities.

The following dates of transmittal of essential data, just for one facility, Hanford Atomic Facility alone, indicates when the data was received:

9/23/76 years of External Radiation Exposure 1944-1975
11/2/75 years of External Radiation Exposure 1944-1974
1/14/75 years of External Radiation Exposure 1944-1973
12/2/72 years of External Radiation Exposure 1944-1971
5/25/70 years of External Radiation Exposure 1944-1968

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3/31/76 years of Internal Radiation Exposures - up to 1974

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3/10/77 Environmental Exposure Records (other than radiation) -
Job craft, occupation, and hazard categories.

- - - - - - - - - -

6/28/76 Employment relative work history data
9/3/1974 " " " " "
10/9/1972 " " " " "
4/6/1971 " " " " "
10/24/1969 " " " " " Basic File

- - - - - - - - - - -

7/5/1976 From Oak Ridge - up date of death file of
Hanford employees.

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It is readily apparent - from just a review of the dates of transmission of certain data, that the earliest period that any consideration of external radiation, would have been in the begining of 1973, and that many changes and corrections were made, subsequently until the final data was sent 9/23/76. Similarly it was impossible to consider or analyze the internal radiation data, a very complex data base before April of 1976. Again, it was impossible to consider environmental exposure records, before March 19755 when that data arrived. Similarly, there were a great many changes in the employment work history records - with improvements in late 1972, September 1974 and finally June 1976.

Within this context, the first processing of the Hanford Employees through the Social Security system to identify the deceased had a cut off of 1972. Subsequently, approximately 2 years were required to search and identify the death certificates, code the causes of death and related information, and integrate the data into the system. Consequently, causes of death, as reflected by the death certificates could only have been available subsequent to 1973. Succeeding processing through Social Security for the Hanford Employees occurred in 1974 and 1976 and required subsequent searches for death certificates. The death and related data for the Oak Ridge Employees was still in process in 1976.

It is, therefore, reasonable to question the validity of the criticism of "reluctance to publish", not only because of the late dates of the availability of certain data in different points of time, but also basically because of the long latent period of occupational cancer in which premature analysis would have been misleading. The combination of both reasons would have made any earlier reports grossly misleading.

It would help in understanding that statement of adverse peer reviews, if Dr. Sidney Marks who helped prepare the 1/8/76 memorandum would state for what years the reviewers made that statement, who the reviewers were, and whether they were fully informed of what was involved in developing the research data over the years. Since Dr. S. Marks knew of the time in years required, an appropriate qualifying explanation would help subsequent readers of the 1/8/76 memorandum as is occurring now, to put the sentence in proper perspective.

Within this same context of "reluctance to publish~~", is~~ a further quotation Page 2 of the 1/8/76 memorandum.

"The deficiencies in performance under the contract include a reluctance to initiate analysis until all the data collection has been completed. Since feedback from the analysis for further data collection is desirable, it is customary to start the analyses of the data early in the study. Dr. Mancuso began the analysis relatively late and for the most part, under pressure from the AEC staff". (Emphasis added).

This is acknowledgement that AEC-ERDA pressured me to conduct analyses, "before they could be meaningful" and disregarded the principal investigator's judgment as to the proper time to conduct such analyses.

Further, the ERDA staff, are technically wrong in judgment, to require an early analysis before all the data is in. Again, this is an illustration of the ERDA staff deciding what should be done, relative to analyses even if is contrary to the judgment of the principal investigator. If a research study is to be independent as it should be, then the judgment of the principal investigator takes priority in the analysis and publication of the data.

So, it can be interpreted from this quotation from the memorandum of 1/8/76 that unless the principal investigator agrees with the interpretation of the ERDA Contractor, as to when and what to do, with his own research study, then the principal investigator can be faulted as occurred in my case.

Again this quotation from Page 2 - must be considered in relation to the quotation from Page 1 - of the 1/8/75 memorandum by Dr. Sidney Marks, quotation from last paragraph:

"Data in the study has been analyzed only for the Hanford plant. Those analyses were initiated only after pressure on the investigators from ERDA staff. Dr. Mancuso's inclination is to achieve something approaching perfection in the quality of the data before starting analyses. This is not a feasible modus operandi for a study such as this in which large bodies of data are accumulated in necessarily imperfect form". (Emphasis added).

The criticism by ERDA of the principal investigaor because he desires to "achieve something approaching perfection in the quality of the data before starting analysis", can not in any degree of honesty be considered a "fault" or proper reason for termination of the research study.

Rather, this criticism "to try to achieve perfection in the quality of the data" before analyses, is a remarkable tribute of scientific integrity of a research investigator to ensure the highest quality of the data before the analysis is done. This is a commendable characteristic of a research investigator. Consequently, ERDA's criticism of me for trying to reach the highest standards in the data collection and organization in any research study and in a study of such national and international importance - can not be considered justified for either scientific or administrative reasons.

Again, this quotation illustrates that the ERDA staff determines what the "modus operandi" of a research study should be, and not the principal investigator. If the principal investigator, decides to pursue the objective of the "highest standards possible in the quality of the data" and decides that"early analysis would be misleading" and "not meaningful" then the principal investigator is faulted by ERDA staff and the project terminated.

What is remarkable about all of this is the contradiction and inconsistency of ERDA's position. ERDA has criticized the "lack of publication" of scientific reports (as in the memorandum of 1/8/76), and accepted this as a main reason for termination of the research contract, yet ERDA as of 9/29/77 acknowledged that it would have been extremely difficult to conduct meaningful analys at an earlier time.

The letter(4) from Dr. Walter H. Weyzen, Manager Human Health Studies Program, Division of Biomedical and Environmental Research, to Ms. Pat Borchmann, Poway, California 92064, dated 3/29/77, states on Page 2 - last paragraph:

"Most cancer have latency period of up to several decades"

"Consequently it would have been extremely difficult to conduct meaningul analysis at an earlier time".

This is now, a public acknowledgement by ERDA that prior analyses and publication of such analyses would not have been "meaningful".

This is an acknowledgement that prior analyses and publication during the years in which AEC-ERDA repeatedly urged me to publish the then "negative findings" of the progress reports, would have been misleading to the public and the scientific community as I stated in the introduction to final Report #13, 1977.

This public acknowledgement by ERDA that prior analysis and publication of such analysis would "not have been meaningful" - contradicts ERDA's own statements cited in the meeting memo of 1/8/76 as reasons for "deficiencies of performance" - (Page 2).

What is particularly important to notice is that Dr. Walter Weyzen was one of the inhouse review members that discussed and prepared the 1/8/76 memorandum.

As previously stated by me, prior publication before sufficient period of years had elapsed for the detection of occupational cancer would provide misleading false negative results. Since Dr. W. Weyzen, manager of the Human Research Studies, now admits in the letter to Ms. Pat Borchmann of California, that for the same reasons pertaining to occupational cancer "it would be extremely difficult to conduct meaningul analyses at an earlier time", some questions could be raised as to why the ERDA staff has consistently cited the "poor publication record" as a reason for the termination of the research study.

AGain, on Page 3 of the 1/8/76 memorandum a statement is made "Dr. Mancuso is also reluctant to have the content of his annual reports quoted or cited". This is misleading because the abstracts and all the progress reports, are recorded and progress reports were made available. The only exception I took, was in the period from 1974 on, when I was concerned that the negative progress reports, might me misued to try to counteract Dr. Milham's positive cancer findings and such indications occurred with urging to me to publish my then negative findings.

What Dr. Sidney Marks does not include in that statement (1/8/76 memorandum) is the fact that Dr. Marks advised me that there could be no restrictions imposed on the release of any of the progress reports for these 2 years, under the Freedom of Information Act and, therefore, the temporary restriction on the progress reports of that year was removed as non-operative.

III. In the 1/8/76 memorandum - the statement is made of poor "quality of statistical analysis". Since this related primarily to the work of the actuarial consultant, then the recommendation could have been made by ERDA to the principal investigator that a change be made in the statistical consultant in any of the prior years when the research project came up for review.

During all those prior years, in which the statistical analysis showed negative findings, AEC-ERDA, did not notify me that this research study was in jeopardy because of the use of the actuarial consultant.

Actually, I did in fact change my statistical consultant arrangements beginning in May 1976, this was formalized in July and continued to August 1, 1977, when the project was terminated. Dr. Alice Stewart and Mr. George Kneale became the principal consultants for that last year of the research contract.

In 1974, 75, I stated my plan to obtain additional statistical consultation for review of the data and insisted on this before consideration of any publication in a scientific journal could occur.

Verification of the need for reevaluation of the statistical methods used by the actuarial consultant, occurred in May 1976 and was documented in a letter by Mr. George Kneale to the actuarial consultant (July 5, 1976), in which it was concluded that based upon the prior analysis by the actuarial consultant the radiation exposure would reduce the death rate from all causes by approximately 40%. (See attachment).

As previously stated despite the acknowledgements (1/8/76) memorandum by Dr. Sidney Marks of the questionable quality of the statistical analyses of the prior years, in the AEC research study, this recognition evidently did not deter the AEC-ERDA from urging me to publish the then negative progress reports during the prior years.

It is evident that Dr. Sidney Marks did not refer to or cite the questionable quality of the statistical analysis in the recommended press release he dictated to me, in which he cited the negative findings of the AEC research study as a means of counter acting the positive cancer findings identified by Dr. S. Milham of the deceased former Hanford atomic workers.

The point being made is that ERDA had ample opportunity, to stipulate that a change in statistical consultants be made during the research contract. Yet there was no directive at any time to me to do this, while the progress reports were negative.

It is highly possible that the (2) outside reviewers were very much concerned and rightly so about the previous statistical analyses. Although I had not seen the 1/8/76 memorandum, I had already instituted steps for a change, when Dr. Alice Stewart and

George Kneale were brought into the research study in May 1976.

Since Dr. J. Liverman stated in his letter to Dr. K.Z.Morgan, that the decision was made in the Summer of 1974 because of (Mancuso's) "imminent retirement" (age 62) and no mention at all was made of adverse peer review as a reason by Dr. J. Liverman, and since I had not received any notification prior to 1974 or subsequent to 1974, from AEC or ERDA of any adverse peer reviews it is reasonable to question the impression conveyed of an adverse peer reviews as implied in the 1/8/76 memorandum. It does appear to me that the contents of the 1/8/76 memorandum is now being used to camouflage and divert from the real reason, the positive cancer findings in the Summer of 1974 which prompted the decision to remove the investigation from the independent status taken by me, as the Principal Investigator.

NOTICE OF TERMINATION AND RELATED EVENTS

In March 1975 meeting, Dr. Sidney Marks (ERDA) said to me: "you don't want to continue on this project do you". That statement is easy to remember for anyone who already had spent years on a research project. I replied very clearly and definitely that I did want to continue with that project, that I wanted to devote the rest of my professional career to that study.

ERDA said it was an administrative decision. The question of "imminent retirement" was not the issue, rather the decision had already been made in the Summer 1974, before I came to that meeting. The University of Pittsburgh was formally notified of the termination of the project in a letter 1/16/76. (Attachment)

After 1975 when friends probed Dr. LIverman's office to find out whether a continuation of the Mancuso project could be extended at the University of Pittsburgh, the answer came back each time, that it was an administrative decision to give it to the Associated Universities of Oak Ridge. Never was the word of "imminent retirement" given as the reason for the transfer.

Again, after our positive findings were presented to the ERDA staff, I made it clear that it would be inappropriate to transfer the project when we reached this stage of the analysis. Again, the message came back that there would be no change. The reason of "imminent retirement" was never given.

When Dr. Alice Stewart and George Kneale found in the analysis of the data, in the Summer of 1976, that radiation induced cancers had occurred among former Hanford employees - this information was made known to ERDA. In all the succeeding months of analyses, with further development of the data, the positive findings again were made known to ERDA.

In essence, the option existed for ERDA (since September 1976 to July 31, 1977) to modify its administrative decision, and to make some arrangements to continue the independent study at the University of Pittsburgh.

The decision to move the research to another organization who had to develop the appropriate staff -, at this critical stage of the analyses, does not appear to be in the best interest of science nor in the best interest of the public.

Ever since the positive findings of a definite association of certain types of cancers with low level ionizing radiation were detected by Dr. Alice Stewart, (an International expert in the Epidemiology of ionizing radiation and cancer) together with George Kneale, the Statistical Consultant, a definite change of attitude occurred in the ERDA staff.

For years, the most cordial and pleasant relationships existed when the progress reports all indicated that the findings pertaining to radiation would be negative.

An indication of the changes in relationships after the positive findings was illustrated when Dr. Weyzen of ERDA headquarters obtained the computer tapes from Oak Ridge and had them transmitted to Dr. Charles Land at the National Cancer Institute, against the expressed decision of the principal investigator. A copy of my letter to Dr. Weyzen protesting that action (1a) is attached.

Previously, I indicated to ERDA that I would consider providing certain information to facilitate another consultant group review, but when that event occurred I ceased any consideration of cooperation with anyone that would independently take that course of action. This was interference by the contracting governmental agency.

Again, the concern about the positive findings by ERDA representatives was similar to the period when the positive Milham findings occurred, the impact on the public and ERDA stand that no harmful effects had occurred in AEC facilities.

After the positive cancer findings of this research study on the Hanford Employees were made known, ERDA circulated a series of adverse criticisms of the report and these were referred to in the press.

Although I obtained a few of the earlier critiques, I never did receive what I learned was the major critique prepared by ERDA consultants which was circulating since September 1977. Neither did I receive the critiques of the final report #13. I prepared a chronological sequence of this to illustrate the point which is stated for the record as follows:

Chronological Development of Requests for critiques analysis of the Findings of the AEC Health and Mortality Study (Dr. T.F. Mancuso) obtained under the Freedom of Information Act:

1. July 8, 1977 Dr. T. Mancuso wrote to Dr. Sidney Marks of Battelle Pacific Northwest (formerly of ERDA) requesting the critique of the findings of the AEC Study for that period of time.

2. September 29, 1977. Dr. T. Mancuso wrote to Dr. Sidney Marks advising that he was informed in a telephone discussion with Dr. Alice Stewart in England, that a critique of the latest report of the AEC Health and Mortality Study was being circulated. A request was made for a copy of that report and also a response to the request of July 8, 1977.

3. October 5, 1977. Dr. T. Mancuso telephoned Dr. Sidney Marks again requesting a copy of the latest critique cited in the letter of September 29, 1977, so that the report could be sent to Dr. Alice Stewart and Mr. George Kneale, statistician for review to ascertain any differences and basis for negative critique.

4. October 13, 1977. Dr. T. Mancuso wrote to Dr. Sidney Marks referring to the September 29, 1977 request, and the telephone request of October 5, again asking for a copy of the critique being circulated to send to Dr. Alice Stewart and Mr. George Kneale.

5. November 18, 1977. The newspaper, the Oak Ridger (Oak Ridge, Tennessee, specifically quotes Dr. J. Liverman (ERDA) in response to a question about the Mancuso findings that "he had requested an independent study, the results of which are expected in a few days".

6. December 16, 1977. Dr. T. Mancuso wrote to Dr. Sidney Marks, advising that some material had been received on that day.- (Same portions received under Freedom of Information Act., same week). But that the material did not contain the report requested on September 29, October 5, October 13, that Dr. J. Liverman, stated on November 18, would be "available in a few days".

7. December 29, 1977. Dr. Sidney Marks wrote to Dr. T. Mancuso, saying the report referred to was not completed, "that (Dr. J. Liverman) statement (November 18) was premature in light of subsequent developments".

8. Information pertaining to critiques of the final analysis and final report #13 was obtained under the Freedom of Information Act request No. 77-44- November 15, 1977 pertaining to documents relating to work done by Dr. T. Mancuso, Dr. Alice Stewart and Mr. George Kneale on Hanford workers mortality (ERDA date December 14, 1977 - received December 20, 1977).

    1. Critique date - September 29, 1977
    2. Critique date - October 4, 1977
    3. Critique date - October 19, 1977
    4. Critique date - October 28, 1977
    5. Critique date - November 23, 1977
    6. Critique date - November 25, 1977

All of these critiques of the final data analysis - as reported in final report #13 of the research contract, were only made available to the principal investigator through the Freedom of Information Act.

The response prepared by Dr. Alice Stewart and George Kneale was necessarily confined to these written critiques of final report #13. The critique-document pertaining to the independent study requested by ERDA which Dr. Sidney Marks was circulating since September 1977, was not made available to the principal investigator, so a review-response could not be made by Dr. Alice Stewart and George Kneale.

9. January 23, 1978. Dr. T. Mancuso forwarded the response to Item (8) to Dr. Sidney Marks, Dr. Liverman, Burr, Weyzen, Land, Jablon, MacMahon, Hutchinson, Gilbert, Brodsky and others for their consideration before Congreassional Hearings.

In summary, as I review the events, it does appear difficult to understand after I had developed the Social Security methodology and the data for the project since 1964, and after we had identified the radiation induced cancers, why ERDA thought it no longer appropriate to continue the independent research project at the University of Pittsburgh under my direction, at this critical stage of analysis. The question is what are they afraid of?.

AEC, Press Release read over phone to TFM

We have been informed of Dr. Milham's paper. While we appreciate his efforts to assess possible health effects for workers at Hanford, his conclusions - that there have been an excessive number of cancer deaths among Hanford workers - is contrary to a wealth of information which has been accumulated and analyzed over many years. Reports on this work are available for anyone to examine.

Apparently, unknown to Dr. Milham when he did his work, AEC has, for about 10 years, funded a carefully structured study of health effects among nuclear workers, primarily at Hanford, Washington and OakRidge, Tennessee, by Dr. Thomas F. Mancuso of the University of Pittsburgh. Findings this far include 32,000 Hanford employees; their records are compared to some 20,000 siblings of the same sexes who did not work at Hanford.

The Hanford information indicates that 1) there is no apparent significant difference in radiation-related health effects between Hanford employees and their siblings; and 2) based on scrutiny of some 4,000 death certificates, there is no evidence of cancer or other deaths attributable to ionizing radiation occurring more often among Hanford workers than among other non-Hanford brothers and/or sisters.

We understand that a copy of Dr. Milham's paper has been sent to Dr. Mancuso for review.

University of Pittsburgh

GRADUATE SCHOOL OF PUBLIC HEALTH
Department of Industrial Environmental Health Sciences

February 16, 1977

Dr. Walter H. Weyzen,
Acting Manager
Human Health Studies Programs
Division of Biomedical and
Environmental Research
Energy Research and Development
Administration
Washington, D.C. 20545

Dear Dr. Weyzen:

There are several purposes for this letter.

First, I should like to request that you advise ERDA representatives at Oak Ridge that they should not interfere, directly or indirectly, with what is mailed by my staff stationed at Oak Ridge.

I wish to emphasize that the 2 persons I have stationed at Oak Ridge are personnel of the University of Pittsburgh; that they are directly responsible to me and that no one has the right to tell them what to mail or not mail, nor what procedures are to be carried out, other than the principal investigator.

This complaint is prompted by an incident that occurred at Oak Ridge on February 8, 1977.

Regardless whether the instructions were generated by ERDA representatives at Oak Ridge or in response to your own instructions, I wish to advise you that it is most unusual and, in my opinion, improper for a government agency to interfere with the personnel of any research study regardless who funds the study.

As you can gather, I do not consider this a minor incident and wish to prevent this "symptom" from becoming a pattern by ERDA involving my staff at Oak Ridge.

The second purpose of this letter is to remind ERDA that the provisions of the agreement, that I initiated with Social Security, relative to the AEC Health and Mortality Study was to provide the principal investigator of the University of Pittsburgh, the mortality data for analyses, with necessary assurances of confideniality.

Recently, an event occurred which warrants my concern to ensure that the provisions of that agreement are adhered to.

After I refused your request to transmit to Dr. Charles Land (statistician) of the National Cancer Institute, a copy of my computer tape on the Hanford radiation study, you then requested that the Oak Ridge Computer Center send a copy of my Hanford research records (which were on file storage at the Computer Center) to Dr. Charles Land of N.C.I. The Computer Center then complied with your request as the funding agency. They considered they had no alternative.

In this instance ERDA interceeded and overruled the principal investigator's decision as to the disposition of his own research data, which he has under continual analyses. In terms of principles, I feel that this was an unwarranted intrusion in the scientific research, which should be and must be independent of the government agency supporting the research.

From what I have learned, the programmer at the Oak Ridge Computer Center,fortunately, deleted certain identifying characteristics. Nevertheless, if this had not been done, the event could have been considered a breech of contract by ERDA relative to the confidentiality assurances with the Social Security Administration.

I have just learned of another event that ERDA has already permitted an agreement with the International Nickel Co. for the use of the data generated in my research study of the former AEC workers at Oak Ridge without the knowledge or permission of the principal investigator.

It was my original design, years before anyone recognized the importance of this aspect, that I included the metals and other carcinogent agents in the AEC research study, in order to avoid the problems of attributing to radiation, the effects that might be due to other industrial causes.

Again, recently, I have been contacted by the Chicago office of ERDA, the contracting officer, through the University of Pittsburgh about obtaining "Union Carbide death certificates".

In the first place, Union Carbide (Oak Ridge) has all the Oak Ridge death certificates, because a copy of every death certificate on (Union Carbide) Oak Ridge personnel is already at Oak Ridge. If this request pertains to Hanford deaths. Then the request does not apply because Union Carbide has no authority responsibility for Hanford data. A separate memorandum will be sent to the Chicago office relative to this matter.

You should be aware of the fact that the Oak Ridge Computer Center is not the repository for all the Hanford study data. The Oak Ridge Computer Center has only been delegated specific responsibilities from time to time when and as I deemed to be appropriate. I have not authorized any analysis of the Hanford data by the Computer Center at Oak Ridge.

I would appreciate your attention to these matters, so that there will not be any recurrences and that cordial relationships will be maintained.

Sincerely,

Thomas F. Mancuso, M.D.
Research Professor
Department of Industrial
Environmental Health Sciences

TFM:ses

cc: Dr. W. Burr
Dr. N. Wald
Mr. J. Thompson

MEMORANDUM

Meeting: 1/8/76

BIOMEDICAL PROGRAMS

5. University of Pittsburgh, Pittsburgh, Pa. - E(11-1)3428
Investigator: Thomas F. Mancuso, M.D.
Title: "Study of Lifetime Health and Mortality Experience of Employees of ERDA Contractors"
Previous allocations: $1,463,702 for 6/1/64 thru 7/31/75
53,286 for 8/1/75 thru 10/31/75
35,500 for 11/1/75 thru 12/31/75
Amount: $282,732 - $21,315 unexp. = $261,417
SRSA Contract

Summary: Sidney Marks, M.D.

Category: Health Studies - Effects of Energy-Related Pollutants on Man - Epidemiological Studies

Outside reviews:

Inside reviews: Weyzen, Beadle, Wachholz, Schroebel

The Health and Mortality Study, now in its twelfth year, represents an attempt to establish whether any harmful effects result from employment in ERDA contractor facilities. By implication, the relationship of radiation exposure to health is studied in the project because radiation exposure is the unique feature that distinguishes these from other industrial facilities.

The study included only Hanford and Oak Ridge plants initially, but Dr. Mancuso, the principal investigator, intended to include eventually the workers at all major ERDA facilities in the study. Since progress in developing usable results has been very slow, ERDA has limited the study to those two facilities with the addition of Mound Laboratories in recent years. In addition, Dr. Mancuso has accumulated considerable data from small facilities that were discontinued at an early date and from uranium feed plants, such as the Mallinckrodt plants in Missouri and the National Lead Plant in Ohio.

Data in the study has been analyzed only for the Hanford plant. Those analyses were initiated only after pressure on the investigators from ERDA staff. Dr. Mancuso's inclination is to achieve something approaching perfection in the quality of the data before starting analysis. This is not a feasible modus operandi for a study such as this in which large bodies of data are accumulated in necessarily imperfect form. The status of the studies at the three principal plants will be presented briefly here.

Hanford

Dr. Mancuso has studied the Hanford population more extensively than the other facilities. His first analyses were conducted in 1972 and consisted of a comparison of longevity of Hanford workers with that of their siblings. An analysis of mortality due to specific causes of death was undertaken in 1973. Those results pertained to a comparison, again, of the workers and their siblings. In 1972, Dr. Mancuso provided analyses of the population of workers with radiation exposure versus the unexposed employees. More recently, he has analyzed cancer deaths relative to levels of exposure. In that analysis, the population has been divided into quartiles in increasing order of cumulative life-time exposure.

Oak Ridge

No analyses have been performed on the Oak Ridge population but, at present, death certificates to provide causes of death are being obtained from the states. A recent hang-up has been a discovery that several thousand individuals were found in various files, such as medical or monitoring files of the plant, without appearing in the personnel files that were used to compile the roster for the study. Dr. Mancuso has diverted some of his resources to check out the completeness of the roster relative to those names. However, the progress of the study has not been retarded greatly because insufficient death certificates have been procured from the states to permit the analysis of Oak Ridge data to be started.

Mound Laboratories

The employee roster has been completed at Mound Laboratories, and deaths have been identified. However, the sibling data has not been sent to Social Security Administration for identification, and death information has not been obtained on that control group. This is projected as an activity to be accomplished during the next year.

Organization

The study is conducted at the University of Pittsburgh with a field office in Oak Ridge and with cooperative groups in the Oak Ridge Union Carbide Computing Center and in the Hanford Environmental Health Foundation. The latter two groups are funded separately by 189's. A small separate group is also present at Mound Laboratories. The University of Pittsburgh staff includes Dr. Mancuso as a half-time employee and seven full-time staff, as well as some part-time clerks. Consultants are also attached to the

University of Pittsburgh office. Dr. Sanders, who is physically located at San Diego, is the principal consultant. Dr. Mancuso plays an administrative role in the study. The actual conduct of the study is carried out by Dr. Sanders, who is an actuary with extensive experience in the Social Security Administration and in the Public Health Service. The consulting staff includes a computer specialist, health physicists and some services of a statistician. The operations in Oak Ridge and Richland are staffed by medical record and computing personnel.

Evaluation

This contractor has done certain commendable things. He has taken great pains to refine the data as much as possible and to provide quality controls for the data. This aspect of his work is commendable since the old records (dating back to 1942) are deficient in many respects. He has also refrained from drawing premature conclusions when early results have indicated that some effect may be present. He has properly accepted those results as leads for further inquiry and, in the process, has discovered biases, which account for the results. Since such biases are apt to creep into some portions of the data in a study as large as this, patience in checking out results is desirable.

The deficiencies in performance under the contract include a reluctance to initiate analysis until all data collection has been completed. Since feedback from analysis for further data collection is desirable, it is customary to start the analysis of the data early in the study. Dr. Mancuso began the analysis relatively late and, for the most part, under pressure from AEC staff. A second problem has been a reluctance by the investigators to publish. He has not, as yet, published any papers in edited journals. At this stage, he could at least have published the methodology, the plan of the study, and some preliminary results. His results have appeared only in annual reports and as an unedited document in connection with a presentation to a health physics symposium. Dr. Mancuso is also reluctant to have the content of his annual reports quoted or cited. Reviewers of the study have criticized the poor publication record of the study. Another difficulty is the quality of the statistical expertise among the investigators and of the statistical analyses. Despite his abundant experience as an actuary, Dr. Sanders is not a qualified statistician and has not used the best available techniques. In the past year or two, Dr. Mancuso has expressed interest in bringing better statistical talent into the study but has not succeeded in accomplishing this objective. Another defect has been the faulty belief expressed by both Mancuso and Sanders that enlarging the population under study to include all major AEC facilities would solve intrinsic deficiencies in the study and permit them to produce refined differences between their study and control populations. In truth, the biases that tend to make control populations imperfect are independent of the size of the study group in a study of this type. Therefore, doubling or trebling the population would accomplish little toward producing a more perfect study.

Reviews

Outside reviews by were unfavorable. Both reviewers felt that Dr. Mancuso's call for additional funding and an enlarged study population is not justified. They felt that expansion of the study would dilute the effort and be counterproductive. recommended that the study be terminated at the end of the current contract year in July 1976. complimented the investigators on their careful, meticulous work to date but was critical of Dr. Mancuso's request to enlarge the study. Both reviewers agreed that the study was important and should be continued although recommended that the study be turned over to a different principal investigator.

ERDA Plans for the Health and Mortality Study

In March of this year, Dr. Mancuso was informed at a meeting in ERDA Headquarters that his contract would be extended until August 1, 1977, but that it would be terminated at that time. In 1974, at the time of a major scaling down of the clinical program at ORAU, plans for enlargement of the ORAU activities in the area of human studies were developed. The possible assumption of responsibility for the Health and Mortality Study was included among the projects to be considered for development at ORAU. Since then, the ORAU Medical Division has been informed that, if they develop the necessary expertise, the Health and Mortality Study will be transferred to ORAU and is to be phased in during the last year of Dr. Mancuso's contract, which would begin on August 1, 1976. Dr. Lushbaugh, Director of the ORAU Medical Division, will soon hire an epidemiologist and a statistician, who will then begin to phase in to the Health and Mortality study after August 1, 1976. The sensitivities associated with the study of workers in the nuclear industry constitute a compelling argument for providing an orderly transition from the current to a new principal investigator. On the grounds of performance alone, there would be justification for an earlier termination of this contract, but the exigencies of the situation justify continued support of Dr. Mancuso's effort at approximately the current level with transfer of the study to take place in accordance with the schedule that has been established. Data collected during this interval will be useful to the new contractor.

Recommendation

I recommend approval of this contract at last year's level of expenditure of $213,145 plus a 7 percent cost-of-living increase, providing a total of $228,065.

RECEIVED JAN 21 1976

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

JAN 16 1976

Thomas F. Mancuso, M.D.
Research Professor
Occupational Health
Graduate School of Public Health
University of Pittsburgh
Pittsburgh, Pennsylvania

Dear Dr. Mancuso:

I wish to inform you that the Research Committee has approved renewal of your project, "Study of Lifetime Health and Mortality Experience of Employees of ERDA Contractors," under Contract No. E(11-1)-3428.

In accordance with a plan discussed at a meeting in ERDA Headquarters on March 6, 1975, the contract with the University of Pittsburgh will be terminated on July 31, 1977. The Medical Division of the Oak Ridge Associated Universities (ORAU) will conduct the ERDA Health and Mortality Study subsequent to that date. The next contract period from August 1, 1976, to July 31, 1977, will offer an opportunity for ORAU personnel to become sufficiently familiar with the study to provide an orderly transition in its management. During that period, personnel transfers and the later use of consultants from existing staff will be discussed.

Negotiation of a contract is the responsibility of the Chicago Operations Office, and you may expect to hear from someone in that office in the near future. Responsibility for the technical aspects of the work rests with the Division of Biomedical and Environmental Research.

Sincerely,

S. Marks

Sidney Marks, M.D.
Analysis and Assessment Programs
Division of Biomedical and
Environmental Research

cc: Chicago Operations Office

University of Pittsburgh
GRADUATE SCHOOL OF PUBLIC HEALTH
Department of Industrial Environmental Health Sciences

August 12, 1976

Mr. Albert Fred Becher
U.S. ERDA
Oak Ridge Associated Universities,
Incorporated
P.O. Box 117
Oak Ridge, Tennessee 37830

Dear Mr. Becher:

The attached letter to Dr. Barkev Sanders was sent through me. I asked Dr. Robert Elston, Professor of Biostatistics, University of North Carolina to explain the formula. This is added to the letter.

Sincerely,

Tim

Thomas F. Mancuso, M.D.
Research Professor
Department of Industrial
Environmental Health Sciences

Enclosure

TFM/fam

PITTSBURGH, PA. 15261

BIRMINGHAM REGIONAL
HOSPITAL BOARD

UNIVERSITY OF
BIRMINGHAM

UNITED BIRMINGHAM
HOSPITALS

REGIONAL CANCER REGISTRY

QUEEN ELIZABETH MEDICAL CENTRE
BIRMINGHAM B15 2TH

TELEPHONE:
[redacted]
021-472 1311 Ext.

27th July 1976.

Dear Dr. Sanders,

I am, I hope, not prejudiced in favour of finding either that radiation is bad for an exposed person or good for him. But when an apparent effect exceeds any biologically plausible amount by at least an order of magnitude, one tends to suspect that there may be something wrong with the data. The effect I am talking about is one that you yourself pointed out, namely the tendency for surviving employees to have higher cumulative doses than non-survivors, either cancers or non-cancers. Referring to table 4 of your report, as sent to Dr. Mancuso, "Low level radiation and cancer deaths", the distribution of signs in column 12 is, as you point out, highly significant.

Before any valid comparison of the survivors with the comparatively small group of non-cancer deaths can be done, one must obviously clear out of the way any possible effect associated with the mere fact of death. Dr. Stewart and I came to Pittsburgh with the intention of primarily clearing up this point, and then seeing if any light were shed on the comparison of survivors and cancer deaths by so doing. At first we supposed, as you did, that the effect was due to lower exposure of dead persons in the years immediately preceeding death, but by pushing the cut-off date back 5 or even 10 years we found we could not account for the effect in that way.

I then tabulated person-years at risk of exposure in various ways for survivors, non-cancers, cancers and dead without death certificates. We found that the difference between survivors and non-survivors persisted however the analysis was done and was matched by a parallel difference between deaths with and without death certificates. A typical finding, from table 2 of the set you have, is that in 1962, 40% of the person-years at risk had been exposed among the survivors, 30% among the cancers, 28% among non-cancers and 10% among dead without death certificates.

Taking these findings at face value would imply that the relative risk of dying of non-cancer given exposure, by a standard epidemiological argument was

$$\frac{0.28\ (1-0.40)}{0.40\ (1-0.28)} = 0.58$$

In other words the risk of dying was reduced by 42% ! This is so large as to defy belief even in the most confirmed believer in the beneficial effects of low level radiation. Therefore any conclusions to be drawn from the survey ought to wait until the cause of this apparent artefact is explained.

Yours sincerely,

George W. Kneale.

George W. Kneale.

(Dr. R. Elston explains the formula:

"The relative risk is equal to the risk of dying of noncancer, given an employee is exposed to radiation, divided by, risk of dying of noncancer given an employee is not exposed to radiation. The formula is an approximation which is good in this situation.")

Estimated Additional Costs 1973-1975
(based on past Social Security costs)

	Employees		Siblings		Total	
	Population	Costs	Population	Costs	Population	Costs
1. Argonne National Lab.	20,000	$ 9,000	33,350	$ 21,272	53,350	$ 30,272
2. Brookhaven National Lab.	6,750	3,038	11,250	7,173	18,000	10,211
3. Dow Chemical Co.	11,750	5,288	19,585	12,493	31,335	17,781
4. E.I. duPont Savannah River	8,500	3,825	14,170	9,033	22,670	12,858
5. Lawrence Radiation Lab./ Berkeley	6,000	2,700	10,000	6,377	16,000	9,077
6. Lawrence Radiation Lab./ Livermore	12,500	5,625	20,850	13,288	33,350	18,913
7. Los Alamos	21,500	9,675	35,850	21,468	57,350	31,143
8. Monsanto Mound Lab.	6,000	2,700	10,000	6,377	16,000	9,077
9. Nat'l Reactor Testing, Idaho Falls	25,000	11,250	41,675	26,586	66,675	37,836
10. Sandia Livermore } Albuquerque }	21,000	9,450	35,000	22,323	56,000	31,773
Total	139,000	$62,551	231,730	$146,390	370,730	$208,941

7/23/70

Appendix 1

Enclosure 14

MAR 29 1977

Ms. Pat Borchmann
13901 York Avenue
Poway, California 92064

Dear Ms. Borchmann:

Your letter to Mr. D. C. Bauer, Division of Nuclear Research and Applications, referring to an article in the Los Angeles Times (10/27/76) was sent to me for response.

The article refers to an ERDA supported epidemiological study of the health and mortality experience of workers in the nuclear industry at Hanford. This study is being conducted by the University of Pittsburgh with Dr. T. Mancuso as principal investigator. Specifically, the cause of death of about 3,800 workers that have died between the start of activities at Hanford around 1942 and 1972 was analyzed for evidence of excess mortality from various causes. Dr. Mancuso and co-workers, in an as yet unpublished paper, identified an increase in the incidence of cancer of the lung, breast, and pancreas, leukemia, and multiple myeloma at relative low levels of cumulative radiation exposure. In view of these unexpected results as compared to present available data on other populations exposed to radiation, and the potential importance of such data for protection of workers and the general public, an independent analysis of the Hanford data was made.

Drs. Marks and Gilbert, Battelle-Pacific Northwest Laboratories, Richland, Washington, using the same data base, were unable to confirm the findings of Dr. Mancuso and co-workers. More recently, an analysis was conducted at the request of ERDA by Dr. C. E. Land of the National Cancer Institute, NIH, Drs. G. Hutchison and B. MacMahon of the Harvard School of Epidemiology, and S. Jablon, National Academy of Sciences, Washington, D. C. Results of this analysis appear to

I+P-2-"B"

indicate an increased incidence of cancer of the pancreas and multiple myeloma. The report, however, emphasizes that "the possibility exists that the results for pancreatic cancer and multiple myeloma are statistical flukes. Excess risks of multiple myeloma and pancreatic cancer, among other cancers, have been reported among U.S. and British radiologists. On the other hand, the evidence for a dose response for these two diseases among Japanese A-bomb survivors is very weak." Also, the staff of the Office of Standards Development of the Nuclear Regulatory Commission (NRC) analyzed Dr. Mancuso's findings. Dr. M. Parsont of the NRC concluded that the results obtained by Dr. Mancuso could not be supported by the information presented.

It should be noted that even the best epidemiological studies to estimate radiation effects in human population are beset by many difficulties and formidable requirements in terms of population size, adequate controls, dosimetry, duration of follow-up and extraneous co-acting variables. The requirements and difficulty of such studies increases enormously for studies of risks at low levels of radiation exposure such as those on Hanford workers. The apparent differences in results of Dr. Mancuso's study compared to the other analyses appear to be attributable to the improper use of particular statistical methodologies. Further studies are underway of Hanford workers and other exposed populations to establish more accurate radiation risk for human populations.

As indicated earlier, studies of this kind are very complex. Most forms of cancer have latency periods of up to several decades. Follow-up studies well exceeding the latency period are required to accurately establish the incidence of these cancers. In addition, the process of data collection on each individual in the population of interest requires a thorough search of all available records, a process that is quite costly and time consuming. Consequently, it would have been extremely difficult to conduct meaningful analysis at an earlier time. At no time were any studies of this kind or results of studies subject to classification. It has been consistently the position of this Agency that studies of this kind are of great importance in protecting the public. They are supported with public funds, and, hence, the results are available to the public.

I have taken the liberty to forward your letter to Drs. Mancuso, Parsont, and Marks with the request to make their findings on the Hanford workers available to you. A report on the analysis by Dr. Land, NCI, is not yet available.

If I can be of further assistance to you, please do not hesitate to contact me.

Sincerely,

Walter H. Weyzen, Manager
Human Health Studies Program
Division of Biomedical and
Environmental Research

Radiation Exposures of Hanford Workers Dying From Cancer and Other Causes

A Review of Written Criticisms by A.M. Stewart and G.W. Kneale

Excerpts from Written Criticisms Requisitioned by ERDA, Circulated to Other Government Departments and Obtained Under the Freedom of Information Act:

(i) I am skeptical about the appropriateness of the tests employed to the kind of data you have, and all that flows from that.

(ii) This report does not involve methods of analysis appropriate for epidemiologic studies of mortality.

Inferences about dose-effect relationships are based on haphazard case-control designs without adequate consideration of possible confounding variables.

(iii) If there are radiation effects to be found in this excessively manipulated body of data they are only for multiple myeloma and cancer of the pancreas.

The tests used are wrong — they return probability values that are much too small because of the very skew distribution of doses.

(iv) They have done proportional analysis and we are doing a population-based analysis.

(v) Lung cancer is reported as being a radiation effect demonstrated by the data [but] table 15 is a very slender reed upon which to rest this conclusion.
In tests of 26 different cancers the probability of obtaining at least two [p-values] as extreme as .01 is about .02.
Adjusting for the presence or absence of internal radiation would probably remove, or severely weaken, all evidence of an association between cancer mortality and external radiation dose....The doubling dose calculations can only be described as mischievous [since] an ad hoc statistical procedure has been used without the benefit of a study of the properties of the estimates obtained using the procedure.

(vi) The data has not been handled in the usual method applied to longitudinal studies.
Case-control studies must either enter all relevant factors in a multivariate analysis framework or control for these factors in the selection of cases and controls.
The statistical techniques were adequate although not the usual ones which we used for such studies.

(vii) The study does not employ the standard epidemiologic methods which have been developed to avoid misinterpretations of findings of causation of disease.

(viii) I would advise that this report has very little scientific value. [The authors have failed to] see contradictions between the original data and the results of a method in which they have invested implicit faith.

Replies:

I. Basic Methodology

It is clear that critics of our report are more familiar with the statistical procedures which allow comparisons between actual and expected cancer deaths (Standardized Mortality Ratio or SMR Methods), than with the procedures which allow comparisons between mean doses of cases and controls (Comparative Mean Dose or CMD Methods).

Therefore we will justify our choice of statistical analysis by demonstrating the relative efficiency of the SMR & CMD methods when faced with the problem of deciding whether any cancer deaths in a population of approximately 30,000 adults had been caused by exposure to supposedly safe doses of radiation.

(1) Let a population of size N be exposed to a radiation dose distribution of f(x) with a mean dose (R) and a variance (V) such that:

$$R = \int_0^\infty xf(x)dx \text{ and } V = \int_0^\infty (x-R)^2 f(x)dx.$$

(2) Let the risk of a cancer death increase linearly with the radiation dose from level A at zero dose (normal cancer risk) according to doubling dose (D), such that the risk for dose x is $A(1+x/D)$.

(3) Let n be the number of cancer deaths actually observed in a study population with a mean radiation dose r.

Given these conditions the necessary size of the base population for detecting a given doubling dose (at a given size and power of the test) will depend upon which approach is taken. Thus the SMR method will require a known value of A which can probably be obtained from official sources (e.g., in Britain, the male cancer death rate is currently in the region of 2,600 per million). Under the hypothesis of no radiation effect, the number of cancer deaths actually observed (n) would have a Poisson distribution with AN as the mean value. Therefore, provided N was large enough to apply a normal approximation to the Poisson distribution, the condition for significance would be

$$n > AN + t\sqrt{AN}$$

where t is the critical normal deviate corresponding to a given significance level (or size of the test).

One now requires the power of the test, or the probability of the significance condition being satisfied under the hypothesis of some radiation effect (with D as the doubling dose). Under this hypothesis the number of cancer deaths actually observed (n) would have a Poisson distribution with AN(1+R/D) as the mean value. Therefore, the required power would be

$$\Phi\left[\frac{AN + t\sqrt{AN} - AN(1+R/D)}{\sqrt{AN(1+R/D)}}\right]$$

where Φ is the integrated normal distribution.

If the power of the test is given the convenient value of 1/2 (so that one is equally likely or unlikely to detect a significant difference between actual and expected cancer deaths), the argument to ϕ will become zero — or $t\sqrt{AN} = ANR/D$ — and the necessary size of the base population will be $\frac{t^2D^2}{AR^2}$.

Therefore, to detect a doubling dose of 15 rads with a mean radiation dose of 1.6 rads (see Hanford data), and a normal cancer risk of 2,600 per million (at a 5% level of significance, or $t = 1.96$), the SMR method would require a population of 135,000, or one which was approximately 4 times larger than the Hanford population was when we were first consulted.

The corresponding calculations for the CMD method are as follows. On the hypothesis of no radiation effect the mean cancer dose (r) would have an approximately normal distribution with mean R and variance V/n. Therefore, the condition for significance would be $r > R + t\sqrt{V/n}$. On the alternative hypothesis (of some radiation effect with doubling dose D) the mean radiation dose (r) would have an approximately normal distribution with $\frac{R+(R^2+V)/D}{1+R/D}$ as the mean value.* Therefore, the condition for a power of 1/2 would be

$$t\sqrt{V/n} = \frac{R+(R^2+V)/D}{1+R/D} - R.$$

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*This is proved in the Appendix of the published report.

By allowing the approximate mean value of n to be AN the necessary size of the base population would be $\frac{t^2(D+R)^2}{AV}$. Therefore, to detect a doubling dose of 15 rads with a mean radiation dose of 1.6 rads (and the additional information that for Hanford males $\sqrt{V}$ = 3.6 rads) the CMD method would only require a population of 32,700, or one similar in size to the Hanford population.

Finally, the general formula for the efficiency of the CMD method (compared with the SMR method) is $\frac{D^2V}{(D+R)^2R^2}$. Therefore the CMD method is in general optimum when the radiation dose distribution has such a wide scatter about the mean as the Hanford doses.

In short, by using the CMD method to identify diseases with radiation effects (and the SMR method to check risk estimates derived from the CMD analysis), we were not only taking full advantage of the fact that there was a complete set of annual radiation doses for every worker but also proceeding along sound statistical lines.

II. Avoidance of Spurious Associations

As stated in the published report we always intended to follow a preliminary analysis of Hanford data with "joint-standardization for all factors with known or suspected radiation and cancer associations." Also, given time, we will certainly extend the analysis to workers who were still alive at the time of the follow-up.

Meanwhile our positive findings were unlikely to be the result of hidden biases for two reasons: they have pinpointed cancers which have always rated high in the ICRP classification of radiosensitivity (e.g., bone marrow, lung and pancreas, see ICRP publication 14); and there was no narrowing of the gap between mean radiation doses of cancers and non-cancers after separate standardization for each of the following factors: calendar year of exposure, period of employment, age at death and pre-death period.

While making our preparations for joint-standardization of these factors the number of certified deaths of exposed workers was increasing, and by the time we were in a position to apply a Mantel-Haenszel test to the null hypothesis of no dose differences between two groups of certified deaths (cancers and non-cancers), the number of exposed workers had increased from 2,307 to 4,032 (table 1).*

This will be the base population for a second report which will include a demonstration of the fact that there has been firm rejection of the null hypothesis (by the Mantel-Haenszel test) after joint-standardization for sex, age and date of death, exposure period and internal radiation (tables 2 & 3). This finding refutes the suggestion that control for internal radiation would probably remove or severely weaken all evidence of an association between cancer mortality and external radiation (see critique V, also note that we have followed the advice of this reviewer and based our repeat analysis on exposed workers only).

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*Our original definition of "exposed" was 1 or more centirads as the penetrating dose; our revised definition was a minimum of 1 centirad as either the skin or extremity dose. All quoted doses are for penetrating radiation.

III. Avoidance of the Difficulty Created by a Wide Range of Diseases with Possible Radiation Effects

The critic who suggested that we confine our attention to exposed workers was evidently in a position to apply to Hanford data independent tests of radiation effects, but he ran into difficulty as a result of recognizing no less than 26 different forms of cancer. Faced with the same problem we first divided the cancers into 2 main and 9 subsidiary groups (see published report) but later adopted the classification recommended by ICRP (see table 4). In this way we not only reduced the number of separate diagnostic categories to 4 but also discovered that most of the cancers which rated high in a completely independent classification of radiosensitivity showed definite radiation effects and none of the ones belonging to other categories (i.e., low sensitivity and not classified). Also lung cancer (for which there was only slender evidence of any radiation effect in the published report) now showed strong evidence of this effect. For one component of the high sensitivity groups (i.e., lymphomas and reticulum cell sarcomas), there was no evidence of any radiation effect among the male cases but included among the female cases was the woman with the highest dose (1,537 centirads). See tables 4 to 9 and figures 1 to 5.

IV. Estimated Doubling Doses

Our decision to include risk estimates in a preliminary report was not motivated by any desire to be mischievous. On the contrary we carefully considered two alternatives: should we suppress the fact that there were cogent reasons for thinking that the cancer hazard associated with low level radiation might be 10 to 20 times greater than was commonly supposed, or should we risk causing unnecessary alarm to an industry in which the dose trend was clearly in an upward direction? We finally decided to publish on the grounds that any safety-conscious industry would keenly resent being kept in the dark on such an important matter.

We made it abundantly clear that our risk estimates were based on small numbers and consequently had wide margins of error. Our new estimates remain well below ICRP 26 recommendations but for three groups of male cancers they have been revised in a downward direction (see all cancers, lung cancers and bone marrow cancers in table 9 and figure 5). The larger numbers also made it possible to include a doubling dose for all female cancers (9 rads) which was appreciably smaller than the corresponding estimate for male cancers (33 rads).

V. Tests of the Reasonableness of our Revised Estimates

In the preliminary analysis we used differences between actual and expected cancer deaths (or the SMR method) to test the reasonableness of the risk estimates derived from the CMD analysis. In the repeat analysis we compared estimates derived from the Mantel-Haenszel analysis, first, with ones based on straightforward comparisons between cancers and non-cancers (table 10) and, secondly, with the doubling dose for all male cancers (figure 6).

According to the first test the external radiation risks were only slightly altered in the controlled as compared with the crude analysis (changing from a relative risk of 1.35 to 1.26 in the highest dose group). However the apparent risks from internal radiation (in the crude analysis) were almost entirely abolished in the controlled analysis.

Therefore contrary to the expectation of several critics, the correlation between internal and external dose operates only to give a spurious internal radiation effect in a crude analysis.

According to the second test the points on the curve for the relative risks of grouped doses in the controlled analysis were clustered reasonably close to the projection line corresponding to a linear dose response relationship (as estimated in the published report).

VI. Principal Reasons for Doubting the Validity of the CMD Analysis

As anticipated in the published report the real reason why so many experts have found fault with our analysis is because our estimates of risk are much higher than earlier ones based on A-bomb survivors. However we are no longer the sole challengers of ICRP 26 recommendations since estimates based on "early entrants" (or individuals who entered Hiroshima and Nagasaki less than 4 days after the explosions) have also proved to be much higher than the ones recommended by the ICRP (see enclosure A, or the letter sent to Nature by Professor Rotblat as recently as December 30, 1977).

Thus there is at least one survey besides our own which suggests that previously accepted estimates of the radiation cancer risk (based almost entirely on the Japanese A-bomb survivors and patients treated therapeutically with radiation) may be about one order of magnitude too low.

There are several possible explanations of these discrepancies. First, the basic linear dose response model assumed in deriving the estimates of doubling dose may be wrong, however this appears unlikely. Second, the effects of fractionation are virtually unknown at these low dose levels. This is important because the populations giving low risks were only exposed for brief periods, whereas Hanford workers usually accumulated their total dose over years or decades. Third, and possibly the most important difference between the various study populations, is the incidence of other diseases. Thus the radiotherapy patients necessarily had another serious disorder and the A-bomb survivors continued to have increased death rates from non-cancers for at least 15 years after their exposures; per contra the Hanford population was at least as healthy as the general U.S. population.

These differences in non-cancer disease rates are important because we have discovered that in children the pre-cancer state is associated with lowered immunological competence and increased rates of secondary infections to such an extent that they are in grave danger of dying before the cancers are diagnosed.[1] As a result of these "latent period deaths" serious discrepancies between the true cancer initiation rate and the observed cancer incidence may be introduced, especially in areas and times with "epidemics" of serious infections and accidents.[2]

References

1. Kneale, G.W. and Stewart, A.M. (1978), British Journal of Cancer (awaiting publication in March), "Precancers and Liability to Other Diseases."
2. Kneale, G.M. (1971), "The Excess Sensitivity of Pre-Leukaemics to Pneumonia: A Model Situation for Studying the Interaction of an Infectious Disease with Cancer," Brit. J. Prev. Soc. Med., 25, 152.

Table 1

New Hanford Data (Exposed Workers):

Certified Causes of Death and External Radiation Doses

	Certified cause of death	ICD Nos. 8th Revision	Exposed Workers	Cumulative Radiation dose in Centirads	
				Totals	Means
Males	Cancers	140-209	743	151162	203
	Cardiovascular	390-458	1987	315299	159
	Respiratory	460-519	198	29578	149
	Violence	800-999	424	55985	132
	Other causes	residue	389	70498	181
	All non-cancer deaths	—	2998	471360	157
Females	Cancers	140-209	89	7865	88
	Cardiovascular	390-458	106	6518	61
	Respiratory	460-519	15	808	54
	Violence	800-999	36	975	27
	Other causes	residue	45	1784	40
	All non-cancer deaths	—	202	10085	50
	Total	Males	3741	622522	166
		Females	291	17950	62

Table 2

New Hanford Data (Exposed Workers): Basic Data for the Mantel-Haenszel Test of No Difference in the External Radiation Doses of Cancers and Non-Cancers

Role(1)	Factor	Factor Levels	Cancers(2)	Non-Cancers(3)
C.F.	Sex	Male	743	2998
		Female	89	202
C.F.	Age at death	Under 40 years	38	206
		40-49 "	96	396
		50-59 "	223	707
		60+ "	475	1891
C.F.	Calendar year of death.	1944-54	69	284
		1955-59	79	327
		1960-64	123	575
		1965-69	181	715
		1970-77	300	1299
C.F.	Internal Radiation	Not monitored	297	1282
		Monitored negative	215	832
		Monitored positive	320	1086
C.F.	Years Exposed	Under 2	280	1223
		Over 2	552	1977
T.F.	External Radiation	Under 8 Centirads	256	1067
		8-31 "	131	592
		32-63 "	119	428
		64-127 "	123	448
		128-255 "	91	320
		256-511 "	48	147
		over 511 "	64	198

(1) C.F. = Controlling factor. T.F. = Test factor.

(2) Cancers = Workers whose deaths were ascribed to malignant neoplasms (ICD Nos. 140-209).

Non-Cancers = Workers with other certified causes of death.

Table 3

Results of the Mantel-Haenszel Analysis

Test Factor	Test Factor Levels in Centirads	Cancer Deaths Observed	Cancer Deaths Expected	t-Value O-E	Relative Risk
External Radiation	Under 8	235	240.6	-0.62	1.00
	8-31	129	146.5	-1.92	0.86
	32-63	119	108.9	+1.22	1.15
	64-127	121	117.9	+0.36	1.14
	128-255	91	89.9	+0.22	1.10
	256-511	47	43.9	+0.59	1.08
	522+	64	58.8	+0.89	1.26

Progressive component t-value 1.99*

*For one-sided levels of significance t-values > 1.65 correspond to $p < 0.05$.

Table 4

New Hanford Data (Exposed Workers), Cancers and Mean Radiation Doses

Cancers ICRP Classification			ICD Nos.	No. of Deaths		External Radiation Mean Doses in Centirads	
				Male	Female	Male	Female
High Sensitivity							
I.	Established	Bone Marrow	203	10	-	861	-
			205	15	1	142	-
		Thyroid	193	1	-	44	-
			Total	26	1	414	0
II.	Apparent	Lymph Nodes	200-1	33	2	133	117
		Reticular Tissue	202	7	1	29	1537
		Pharynx	149	2	-	650	-
		Lung	162-3	215	10	258	52
		Pancreas	157	52	5	391	13
		Stomach	151	44	2	240	109
		Large Intestine	153	69	9	132	80
			Total	422	29	240	113
III.	Low Sensitivity						
		Mouth & Salivary	140-8	23	-	239	-
		Oesophagus	150	19	-	44	-
		Small Intestine	152	2	-	62	-
		Liver & Gallbladder	155-6	18	2	252	231
		Nose & Larynx	160-1	14	-	143	-
		Bone, CT & Skin	170-3	18	6	149	30
		Testis & Penis	186-7	3	-	114	-
		Kidney	189	23	2	178	44
		Eye and CNS	190-2	28	5	170	35
		Other Endocrine	194	-	-	-	-
			Total	148	15	168	60
IV.	Not Classified						
		Rectum	154	20	2	104	30
		Other Digestive	158-9	2	1	38	3
		Breast	174	1	19	-	120
		Uterus & Ovaries	180-4	-	11	-	37
		Prostate	185	52	-	119	-
		Bladder	188	13	-	87	-
		Lymphatic Leukemia	204	3	3	19	70
		Other Haemopoctic	206-9	8	3	23	1
		Ill-Defined Sites	195-9	48	5	93	140
			Total	147	44	96	83
A	All Cancers		140-209	743	89	203	88

Table 5

C.M.D. Analysis of Male Cancers

(ii) Distribution of Exposed Males by Pre-Death Years

Pre-Death Years	Non-Cancers	Cancers (ICRP Classification)				All Cancers
		I	II	III	IV	
29	377	3	54	13	32	102
28	513	4	70	18	39	131
27	642	4	97	25	44	170
26	767	5	117	30	49	201
25	929	8	145	42	56	251
24	1059	9	170	48	70	297
23	1200	11	193	54	79	337
22	1330	13	209	61	85	368
21	1470	14	224	69	92	399
20	1600	15	244	76	97	432
19	1735	16	256	81	100	453
18	1854	20	269	87	106	482
17	1983	20	284	91	110	505
16	2096	20	300	98	114	532
15	2198	20	318	102	118	558
14	2287	21	331	106	123	581
13	2363	22	345	110	124	600
12	2442	22	357	116	128	623
11	2509	22	364	122	130	638
10	2578	22	372	126	132	652
9	2640	22	385	130	134	671
8	2702	22	394	133	136	685
7	2762	23	400	134	138	695
6	2806	23	403	137	140	703
5	2854	26	410	139	140	715
4	2890	26	416	142	141	725
3	2926	26	418	146	141	731
2	2952	26	421	146	144	737
1	2986	26	422	146	146	740
0	2998	26	422	148	147	743

Table 6

C.M.D. Analysis of Male Cancers

(iii) Expected and actual radiation doses for 4 groups of cancers(1)
(Doses in Centirads)

Pre-death Years (3)	Expected Mean Doses (2)	Actual mean doses of cancer cases I	II	III	IV	All Cancers
29	21	52	28	28	25	28
28	22	44	30	34	26	20
27	23	49	29	22	26	28
26	26	41	32	25	27	30
25	27	26	33	25	32	31
24	30	25	34	28	28	32
23	34	34	39	32	30	35
22	37	31	44	32	34	40
21	40	39	49	33	38	43
20	44	47	54	36	40	47
19	48	59	62	41	42	54
18	51	57	68	48	46	59
17	56	83	75	54	51	67
16	61	112	85	59	55	75
15	66	140	95	65	59	83
14	71	161	105	71	61	91
13	77	179	116	78	64	100
12	84	204	125	91	66	109
11	91	235	138	97	68	119
10	98	271	149	102	71	128
9	106	313	159	109	73	137
8	114	346	171	120	75	147
7	121	365	183	131	78	158
6	129	386	195	140	80	167
5	137	374	203	149	83	175
4	143	389	212	154	86	183
3	148	403	222	159	90	190
2	152	413	231	165	92	197
1	155	414	238	169	95	202
0	157	414	240	168	96	203

(1) See ICRP classification in table 4

(2) See Non-Cancers in table 4.

(3) The mean radiation dose for the final year (0) multiplied by the number of workers corresponds to the total radiation dose (see tables 1 and 4).

[illegible]

C.M.D. Analysis of Male Cancers

(iv) t-values for differences between observed and expected doses

Pre-Death Years	t-values for the difference between observed and expected doses				
	Ca I	Ca II	Ca III	Ca IV	All Cancers
29	+1.4	+1.1	+0.5	+0.3	+1.5
28	+1.0	+1.4	0.0	+0.4	+1.5
27	+1.2	+1.3	-0.2	+0.3	+1.3
26	+0.7	+1.5	-0.2	+0.1	+1.3
25	-0.1	+1.4	-0.5	+0.6	+1.2
24	-0.3	+1.1	-0.3	-0.4	+0.5
23	0.0	+1.1	-0.3	-0.7	+0.4
22	-0.3	+1.5	-0.7	-0.5	+0.5
21	-0.1	+1.7	-0.9	-0.4	+0.7
20	+0.1	+1.8	-0.8	-0.5	+0.8
19	+0.4	+2.1	-0.7	-0.6	+1.1
18	+0.2	+2.1	-0.4	-0.6	+1.3
17	+0.8	+2.3	-0.3	-0.5	+1.6
16	+1.4	+2.5	-0.3	-0.6	+1.9
15	+1.8	+2.7	-0.2	-0.7	+2.1
14	+2.0	+2.9	-0.3	-0.8	+2.2
13	+2.1	+3.1	-0.2	-0.9	+2.3
12	+2.3	+3.0	+0.1	-1.1	+2.4
11	+2.5	+3.2	0.0	-1.3	+2.4
10	+2.8	+3.3	-0.1	-1.4	+2.5
9	+3.2	+3.3	-0.1	-1.6	+2.4
8	+3.6	+3.6	0.0	-1.9	+2.7
7	+3.7	+3.7	+0.1	-1.9	+2.8
6	+3.6	+3.7	+1.0	-2.0	+2.7
5	+3.4	+3.7	+0.1	-2.1	+2.7
4	+3.5	+3.8	+0.1	-2.3	+2.8
3	+3.5	+4.0	+0.1	-2.2	+2.9
2	+3.6	+4.3	+0.2	-2.4	+3.1
1	+3.6	+4.5	+0.1	-2.4	+3.2
0	+3.5	+4.6	0.0	-2.4	+3.1

One-sided significance levels for t-values:-

1.7 $p < 0.05$

2.3 $p < 0.01$

3.0 $p < 0.001$

Table 8

C.M.D. Analysis of Female Cancers

Pre-Death Years	Exposed Females		Mean R dose for all Cancers		t-value O-E
	Non-Cancers	Cancers	Expected	Observed	
29	34	11	10	29	+1.7
28	41	19	9	18	+1.1
27	52	26	8	14	+1.0
26	63	29	9	19	+1.8
25	74	32	9	21	+1.9
24	84	37	11	21	+1.6
23	94	39	13	23	+1.7
22	103	43	16	23	+1.1
21	118	46	17	25	+1.0
20	124	49	20	24	+0.5
19	133	50	21	27	+0.7
18	139	57	23	26	+0.3
17	152	62	23	25	+0.2
16	156	64	24	27	+0.3
15	163	66	25	29	+0.5
14	166	68	27	32	+0.5
13	170	69	30	37	+0.6
12	172	72	33	44	+0.9
11	176	75	36	52	+1.1
10	179	76	39	60	+1.2
9	182	78	41	64	+1.3
8	183	79	43	69	+1.4
7	186	80	45	73	+1.5
6	190	82	46	75	+1.5
5	193	86	47	77	+1.6
4	196	87	47	81	+1.7*
3	201	87	47	84	+1.9*
2	201	88	49	85	+1.8*
1	201	89	49	88	+1.9*
0	201	89	50	88	+1.9*

Estimated Doubling Dose for all cancers = 8.6 rads.

* Significant at the 5% level (See table 6).

All Doses in Centirads.

Table 9

New Hanford Data: CMD Analysis of Male and Female Cancers

	Cancers (ICRP Classification)	No. of Cases	Pre-Death Yrs. with Exceptionally High Doses[1]	O-E[2] Maximum t-value	Estimated Doubling Dose in Rads[3]
I. & II.	High Sensitivity				
	Bone Marrow	25	0-15	3.7	3.6
	Lymph Nodes & Reticular Tissues	40	-	0.7	-
	Lung	217	0-20	3.7	13
	Pancreas, Stomach & Large Intestine	165	0-8	2.7	19
	Total	448[4]	0-21	5.3	14
III. & IV.	Other Cancers				
	Low Sensitivity	148	-	0.6	-
	Not Classified	147	-	1.0	-
	Total	295	-	0.3	-
	All Cancers				
	Males	743	0-16	3.2	33
	Females	89	0-4	1.9	9

[1] Actual mean dose (O) significantly greater than expected (non-cancer) dose(E).

[2] O-E = difference between observed expected doses in a given pre-death year.

[3] Assuming a linear model.

[4] Including 1 Thyroid Cancer (see Table 4).

Table 10

New Hanford Data (Exposed Workers): Effects of Certain Standardization Procedures

Factors		Number of Cases		Relative Risk(1)	
		Non-Cancers	Cancers	(A)	(B)
Internal Radiation	Not Monitored	1,282	297	1.00	1.00
	Monitored Negative	832	215	1.12	1.06
	Monitored Positive	1,086	320	1.27	1.00
External Radiation Dose in Centirads	Under 8	1,067	256	1.00	1.00
	8-	592	131	0.92	0.86
	32-	428	119	1.15	1.15
	64-	448	123	1.14	1.14
	128-	320	91	1.19	1.10
	256-	147	48	1.36	1.08
	512+	198	64	1.35	1.26
Sex	Male	2,998	743	1.00	1.00
	Female	202	89	1.78	1.57

(1) (A) Crude Comparisons (see Table 2).

(B) Mantel-Haenszel Analysis (see Table 3).

Sent as letter to Nature

Enclosure A

J. Rotblat

Dec 1977.

Risk Factor for Radiation-Induced Leukaemia among Entrants to Hiroshima

A large number (over 40,000) of persons entered Hiroshima after the bombing for rescue work or in search of relatives. These entrants were exposed to the γ-rays from radioactivity induced in the soil and buildings by the neutrons emitted at fission, and to a lesser extent to fall-out radiation. Hirose (1968) and Watanabe (1974) reported a significant increase in leukaemia incidence among the early entrants, here defined as those who entered the city during the first three days. This paper is an attempt to estimate the leukaemia risk factor in this population.

A. Estimate of average dose

Although no attempt appears to have been made to determine the doses received by individual entrants, it is possible to make a fairly close estimate of the average dose received by them. For this purpose the following assumptions are made:

(a) all early entrants entered Hiroshima 6 hours after the explosion;
(b) they all remained in the city for at least 4 days (which in practice means an infinite period);
(c) they all stayed in an area within a radius of 1000 metres from the hypocentre;
(d) within that area they were uniformly distributed;
(e) the risk of leukaemia is linearly related to the dose.

Assumption (a) follows from the information that a fire raged in the city during the first 6 hours, making it impossible for anyone to enter within a 1000 metres.

Assumptions (b) and (c) are most unlikely. An estimate made on these will therefore give an upper limit to the dose, or a lower limit to the risk factor.

Assumption (d) seems plausible.

Assumption (e) is justified even for low LET radiation at low doses, because the quadratic term is then small by comparison (Brown, 1977).

The average dose is calculated from $\bar{D} = \sum f_r D_r$, where f_r is the fraction of the total early entrant population, who were in a ring at a distance r from the hypocentre ($\sum f_r = 1$), and D_r is the cumulative dose at that distance.

The values of f_{γ} follow from assumption (d). The values of D_{γ} for neutron-induced radioactivity, relative to the value at the hypocentre, are obtained from fig. 6 of the paper by Hashizume et al. (1969). From this the average cumulative dose is found to be 13% of that at the hypocentre.

From the same paper (fig. 10) it is found that the cumulative dose from 6 hours to infinity was 67% of that from one hour after the explosion to infinity. The value of the latter was studied by several authors, and Takeshita (1975) gives as the average value of these studies 101 rad (kerma in air).

Thus, the average dose from neutron-induced radiation is 101 x 0.67 x 0.13 = 8.9 rad.

The dose due to fall-out is also taken from Takeshita. Assuming that the dose was the same over the whole area, the cumulative dose from 6 hours to infinity is 1.5 rad. The total dose is thus 10.4 rad.

To convert kerma into absorbed dose, the factor 0.65, which is applicable to bone marrow, is used. This gives a value for the average absorbed dose of 68 mGy.

An estimate of the error to be attached to this figure can be obtained from the distribution of values given by different authors (Table 2 of Takeshita). The standard error of the mean is about 30%.

B. Calculation of the leukaemia risk factor

According to Hirose (1968) over the period 1950-68, there were 45 cases of leukaemia among the 25798 persons who entered Hiroshima during the first 3 days, and 9 cases among the 18328 persons who entered during the following 12 days.

The assumption is now made that the latter group received zero dose (thus again underestimating the risk factor) and can be used as the control group for the early entrants.

In a population of 25798 one would thus expect to find 12.7 cases of spontaneous leukaemia. The excess of 32.3 then leads to a risk factor of $18 \times 10^{-3}\,\mathrm{Sv}^{-1}$.

The statistical error of the leukaemia incidence is 25%, making the total error 40%.

No information is available about the age and sex distribution of the entrants but it is unlikely that children or old people would be used for rescue work. The majority of the entrants were thus probably of an age group least sensitive to radiation. The sex difference for leukaemogenesis appears to be insignificant.

C. Comparison with ICRP

ICRP 26 recommends a risk factor for leukaemia of $2 \times 10^{-3}\,\mathrm{Sv}^{-1}$. The figure obtained for the early entrants is thus 9 ± 4 times higher. In view of the assumptions made, the actual value is likely to be nearer the upper end of the range than the lower.

The risk factor used by ICRP is based on observations from two groups of populations: (a) medical X-rays (mainly therapeutic); (b) the A-bomb survivors in Hiroshima and Nagasaki.

In the first group only partial body exposure occurred and this may carry a lower risk than that based on the assumption that the risk is proportional to the fraction of bone marrow exposed.

With regard to the A-bomb survivors, it is known that the incidence rate per rad of cancers of the thyroid, breast and lung is lower among them than in other irradiated populations by factors ranging from 4 to 7 (UNSCEAR, 1977). The present estimate for leukaemia incidence is thus in line with these observations.

D. Conclusions

Unless it can be shown that the reported figure for leukaemia among the early entrants is wrong by a large factor, the following conclusions are inescapable:

1. Whatever the reason for the lower incidence of cancer among the survivors of the explosions and the absence of other radiation effects (Rotblat, 1977), it is clear that the results obtained from the A-bomb survivors cannot be used to establish risk factors for "normal" exposure.

2. The risk factors recommended by ICRP are too low, probably by an order of magnitude for leukaemia, and by a somewhat smaller factor for other cancers.

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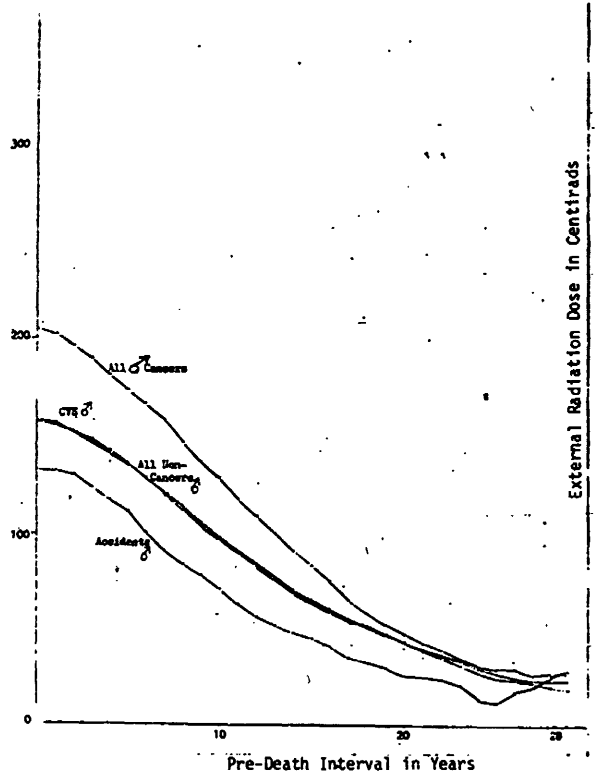
Figure 1: All Cancers (Males)

Figure 2: All Cancers (Females)

CMD Analysis by Pre-Death Years



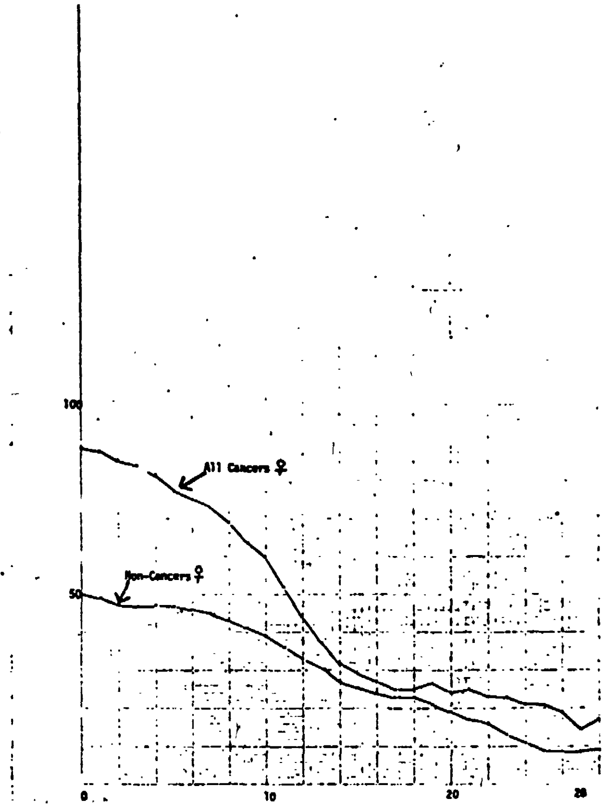
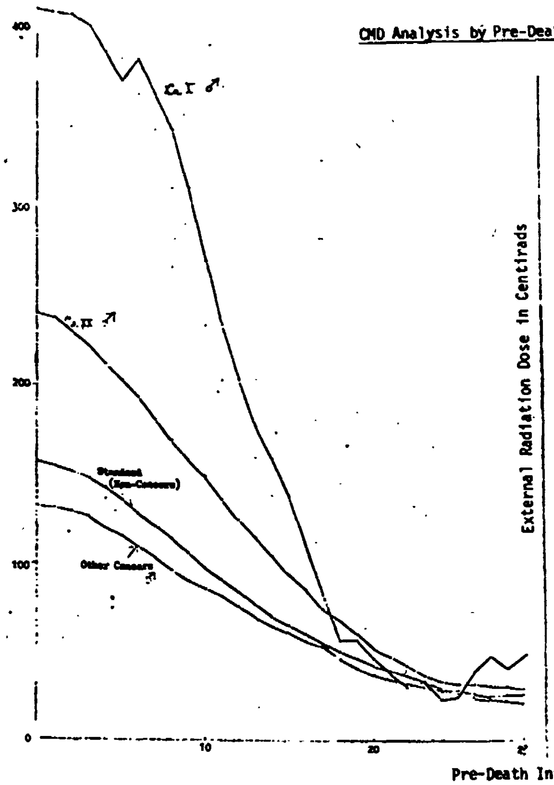
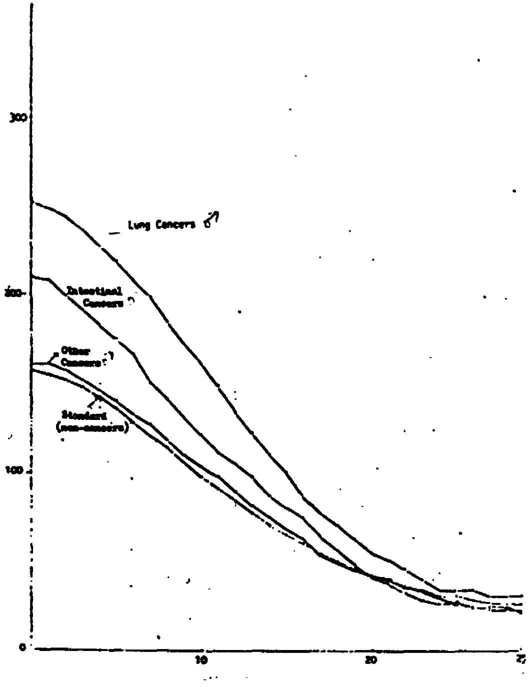


Figure 3: ICRP Classification (Males)

Figure 4: ICD Classification (Males)

CMD Analysis by Pre-Death Years (continued)





Projection Lines for Various Forms of Radiation-Induced Cancers

Figure 5

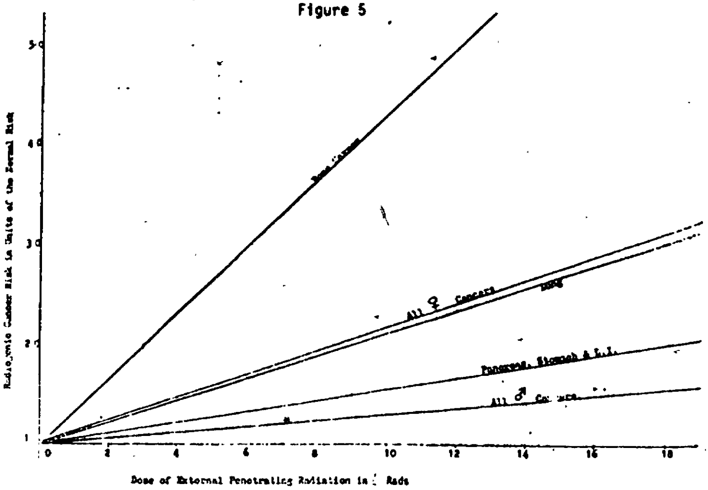
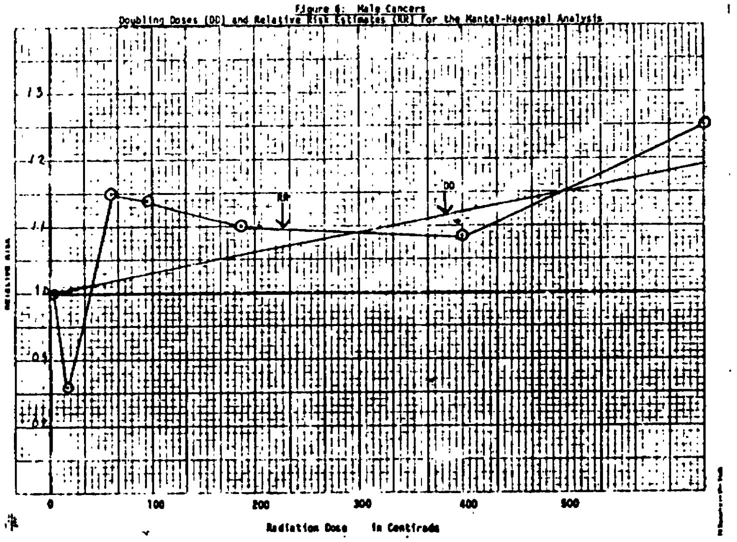


Figure 6: Male Cancers

Doubling Doses (DD) and Relative Risk Estimates (RR) for the Mantel-Haenszel Analysis



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RADIATION EXPOSURES OF HANFORD WORKERS DYING FROM CANCER AND OTHER CAUSES*

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Abstract—Data from the Hanford study have shown that sensitivity to the cancer-induction effects of radiation is at a low ebb between 25 and 45 yr of age. Nevertheless, at younger and older ages there is probably a cancer hazard associated with low level radiation which affects bone marrow cancers more than other neoplasms and cancers of the pancreas and lung more than other solid tumors.

INTRODUCTION

HANFORD Works in Richland, Washington is one of the largest atomic plants in the United States, and most of the staff are in some way concerned with the manufacture of radioactive substances. For these workers, who are predominantly white males, there is systematic recording of data under the following headings as part of a study of the lifetime health and mortality experience of employees of ERDA contractors (Ma71):

(1) Sex, date of birth, date of hire and social security number.

(2) Dates of entering and leaving specified occupations.

(3) External and internal radiation.

(4) Date and cause of death.

The wearing of radiation badges in all workshops and laboratories is obligatory, and the badges are read at frequent intervals to ensure that no worker ever receives more than the maximal permissible dose of 5 rems/yr (BRPC71). In several high risk occupations the workers are also examined (at regular intervals and following accidents or radiation "leaks") for internal depositions of radioactive substances. Therefore, there are both records of the total amount of external penetrating radiation received by each worker by the end of each calendar year (annual doses in centirads) and similar records relating to intakes of radioactive materials (positive urine analyses or internal radiation).

Deaths of Hanford employees are identified through death benefit claims by a nationwide system of social security numbers. These numbers probably provide better identification of males than females but the method of death identification has two major advantages: intervals between discharge and death may be of long duration and there is coverage of all deaths in any U.S. state or territory. Finally, certified causes of death are taken direct from death certificates, copies of which are obtained from official sources and filed with the other records.

Radiation monitoring has been in operation since 1943 and sufficient time has now elapsed for most of the non-survivors to be men who died 10 or more years after leaving the industry. Therefore, from the records of men with certified causes of death we should be able to discover whether NCRP recommendations for protection of radiation workers (BRPC71)—which are strictly enforced by all ERDA contractors—have succeeded in eliminating the cancer hazard or, failing that, are keeping the risk within reasonable bounds. As a first approach to this problem we have examined the records of workers who died within 29 yr of Hanford Works going into full production (1944).

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*Under Contract No. E(11-1)-3428.

PRELIMINARY FINDINGS

Death benefit claims on behalf of men who died before 1973 totalled 3710 and included 3520 certified deaths for the period 1944–1972 (Table 1). Compared with the much larger number of survivors from the same work force, these deaths were strongly biased in favor of the first and largest work cohort. Among the men who were hired during 1944 were some workers who, strictly speaking, were not members of the monitored population (e.g. construction workers). Nevertheless, these men have always been so regarded (Ma74), since, in the early records, there is difficulty in distinguishing between workers in monitored occupations who never received any radiation (non-exposed workers) and workers who were not obliged to wear radiation badges (non-monitored occupations).

The high proportion of non-exposed workers in the 1944 cohort and the relatively low doses recorded before 1954 and by men with short periods of employment (Tables 5 and 6), are reasons why we would expect non-survivors to have lower radiation doses than survivors. This has been a constant feature of earlier analyses of Hanford data (Ma74) and will be mentioned again after we have completed the analysis of certified deaths (see discussion). Meanwhile, it should be noted that division of the certified deaths into cancers (670 cases) and non-cancers (2850 cases) left both groups with the same proportions of men hired in 1944 (48%) and men hired later than 1948 (16%).

In spite of their cohort resemblances the two groups of certified deaths had dissimilar radiation records, also ones which showed that men who eventually developed fatal cancers had been more often and more intensively exposed to external radiation than men with other causes of death (Table 2). Thus the proportion of exposed workers (or men who had one or more positive badge readings) was 66% for cancers and 61% for non-cancers, and for these workers the mean cumulative radiation dose was higher for the cancers (210 centirads) than for the non-cancers (162). Therefore, the "all-worker dose" was appreciably higher for cancers (138) than non-cancers (99).

A classification of the deaths by ICD Nos. showed that for none of the Main Orders of non-malignant diseases was the level of radiation dose higher than the level for all cancers (Table 3). But within the group of malignant diseases there was wide variation in the dose level, also higher doses for RES neoplasms (ICD Nos. 200–209) than solid tumors (ICD Nos. 149–199), and exceptionally high doses for a small group of bone marrow cancers (ICD Nos. 203 and 205). For example, the "all-worker" dose averaged 94 for accidents, 105 for cardiovascular diseases, 114 for digestive diseases, 130 for solid tumors, 219 for RES neoplasms and 449 for bone marrow cancers. Other malignant dis-

Table 2. External radiation records for two groups of non-survivors: cancers and non-cancers

Non-survivors	Cases (Nos.)	Exposed* workers (Nos.)	Cumulative radiation dose (centirads)	Exposed workers %	Mean radiation† dose in centirads A	B
Cancers	670	442	92657	66.0	210	138
Non-cancers	2850	1742	282961	61.1	162	99
All certified deaths	3520	2184	375618	62.0	172	107

*Men with one or more positive badge readings.
†A = Mean cumulative radiation dose for exposed workers.
B = Mean cumulative radiation dose for all workers.

Table 1. Hanford workers; survivors and non-survivors from 1944 to 1971 work cohorts

Cohort*	% Survivors*	% Non-survivors* Uncertified deaths	Cancers	Non-cancers	Totals Nos.	Early discharges*
1944	16.4	41.3	48.7	47.8	5256	49.4
1945	4.7	14.7	12.5	14.5	1524	42.7
1946	2.3	2.0	2.1	3.1	597	19.9
1947	10.3	11.3	12.5	11.0	2615	34.5
1948	7.8	10.7	8.2	7.5	1.927	48.6
1949–71	58.5	20.0	16.0	16.1	13,020	32.3
Total Nos.	21,206	213	670	2850	24,939	9410
Total %	85.0	0.9	2.7	11.4	100.0	37.7

*Cohort = year of hire.
Survivors = alive in 1973
Non-survivors = pre-1973 deaths.
Early discharges = men discharged during the calendar year of hire or the following year.

Table 3. External radiation records for stated causes of certified deaths

Certified causes of death (ICD Nos.)	Totals (Nos.)	Exposed workers* (Nos.)	Cumulative radiation dose (centirads)	Exposed workers* (%)	Mean R dose (centirads*) (A)	(B)
Non-cancers:						
Infective (000–136)	29	16	1258	55.2	79	43
Benign neoplasms (210–39)	10	4	155	40.0	39	15
Endocr. & blood (244–89)	54	34	5199	63.0	153	96
C.N.S. (290–389)†	36	20	3389	55.6	169	94
C.V.S. (390–458)‡	1837	1149	191,987	62.5	167	105
Respiratory (460–519)	194	108	14,330	55.7	133	74
Digestive (520–577)	139	83	15,807	59.7	190	114
Accidents (800–999)	450	271	42,244	60.2	156	94
Residue (580–796)	101	57	8592	56.4	151	85
RES neoplasms:						
Lymphomas (200–2)	34	28	4049	82.4	145	119
Lymphatic Lk (204)	3	2	57	66.7	29	19
Myelomas (203)	11	8	8530	72.7	1066	775
Myeloid leukemia (205)	11	6	1337	54.5	223	122
Residue (206–9)	5	3	58	60.0	19	12
Solid tumors:						
Mouth & pharynx (140–9)	24	14	2134	58.3	152	89
Stomach (151)	38	26	2227	68.4	86	60
Large intestine (153)	61	48	8222	78.7	171	135
Rectum (154)	19	16	1887	84.2	118	99
Other intestinal (150; 152)	18	10	581	55.6	58	32
Liver & gall bl. (155–6)	18	10	557	55.6	56	31
Pancreas (157)	49	31	12,377	63.3	399	253
Lung (162–3)	192	130	32,384	67.7	249	169
Prostate (185)	43	21	1817	48.8	87	42
Kidney (189)	21	14	3935	66.7	281	187
Other G.U. (186–8)	15	10	1225	66.7	123	82
Brain (191)	18	11	3967	61.1	361	220
Residue	90	54	7313	60.0	135	81
Totals:						
Non-cancers	2850	1742	2829.61	61.1	162	99
RES neoplasms	64	47	140.31	73.4	299	219
Solid tumors	606	395	786.26	65.2	199	130

*See footnotes to Table 2.
†C.N.S. = Neurological diseases.
‡C.V.S. = Cardiovascular diseases.

eases with high radiation doses were cancers of the pancreas (253), brain (220), kidney (187), lung (169) and large intestine (135).

In Table 4, the various neoplasms are listed in accordance with the all-worker dose and the number of cases in each diagnostic category is compared with an expected number which shows how the same diseases were distributed among the 1960 cancer deaths of U.S. white males (Bu71). For 8 neoplasms, the radiation dose was higher than the level for all certified deaths (107 centirads) and for 9 the dose was below this level. For the group with above average doses, the observed and expected numbers were 397 and 318 (ratio 1.25), and for the other group they were 273 and 352 (ratio 0.78).

Controlled analyses

The preliminary findings were compatible with a causal association between the radiation exposures and some of the cancer deaths. Therefore comparisons between the two main groups of certified deaths (cancers and non-cancers) were continued in analyses which controlled separately for five possible sources of false impressions, namely:

(1) Calendar year of the exposures.

(2) Employment year of the exposures.

(3) Pre-death year of the exposures.

(4) Exposure age or age at the end of each badge-reading year.

(5) Death age.

Calendar years (Table 5 and Fig. 1)

The calendar year classification showed that: (i) the proportion of exposed workers was higher during the first half of the study period than the second half, but the opposite was true of the annual radiation doses of exposed workers (AREW doses in centirads) and (ii) only during the high dose period were differences between cancers and non-cancers at all pronounced.

Each year the proportion of exposed workers remained a fraction higher for cancers than non-cancers (Fig. 1). However, from

Table 4 Observed and expected numbers of specific neoplasms listed according to mean cumulative dose of external radiation

No	Neoplasms*	Mean cumulative radiation dose (centirads)	No. of deaths† Observed	No. of deaths† Expected	Ratio Obs·Exp
1	Myelomas	775‡	11	7.6	1.45
2.	Pancreas	253‡	49	37.3	1.31
3.	Brain	220‡	18	17.3	1.04
4	Kidney	187‡	21	15.0	1.40
5	Lung	169‡	192	144.4	1.33
6.	Large intestine	135‡	61	63.1	0.97
7.	Myeloid leukemia	122‡	11	5.8	1.90
8.	Lymphomas	119‡	34	27.7	1.23
9.	Rectum	99	19	29.6	0.64
10	Mouth & pharynx	89	24	21.9	1.10
11.	Other genito-urinary	82	15	30.9	0.49
12.	Stomach	60	38	58.7	0.65
13.	Prostate	42	43	67.5	0.64
14.	Other intestinal	32	18	18.0	1.00
15.	Liver & gall bladder	31	18	12.5	1.44
16	Lymphatic leukemia	19	3	9.4	0.32
17.	Other RES neoplasms	12	5	20.3	0.25
18.	Other solid	81	90	83.0	0.59
Nos.	1-8	188‡	397	318.2	1.25
	9-18	65	273	351.8	0.78
	All cancers	138‡	670	670.0	1.00

*See Table 3.

†Observed see Table 3; expected see 1960 cancer deaths of white U.S. males in NCI Monograph 33.

‡ = Above the mean value for all certified deaths (107), see Table 2

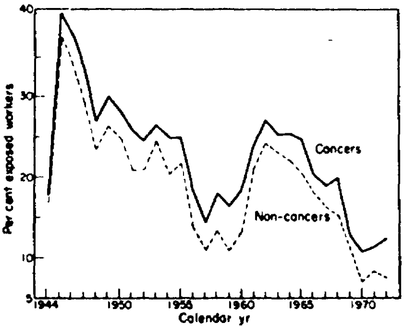

FIG. 1. Per cent of exposed workers by calendar years cancer and non-cancer deaths of males.

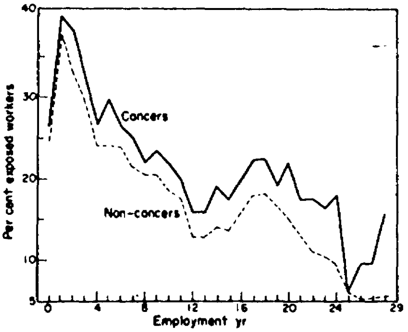

FIG. 2. Per cent of exposed workers by employment years cancer and non-cancer deaths of males.

1944 to 1957 (when AREW doses averaged 14.9 for cancers and 18.7 for non-cancers), there were equal numbers of years with above average doses for the two causes of death (high risk years); and from 1958 to 1972 (when AREW doses averaged 51.3 for cancers and 47.7 for non-cancers), there were more high risk years for cancers (11) than non-cancers (4) (Table 5).

Employment years (Table 6 and Fig. 2)

The employment year classification showed that: (i) the proportion of exposed workers decreased with progressive lengthening of the interval between hire and exposure but the trend for AREW doses was in the opposite direction, and (ii) only during the high dose period were differences between cancers and non-cancers at all pronounced.

Each year the proportion of exposed workers remained a fraction higher for cancers than non-cancers (Fig. 2). However, when intervals from hire to exposure were shorter than 10 yr (and AREW doses averaged 21.5 for cancers and 21.1 for non-cancers), there

Table 5. Mean annual radiation doses for exposed workers (cancer and non-cancers) (calendar years)

Calendar years	Exposed workers* Cancers	Exposed workers* Non-cancers	Radiation doses† Cancers	Radiation doses† Non-cancers	High risk years‡ Cancers	High risk years‡ Non-cancers
1944–45	237	901	26.5	26.0	2	—
1946–47	333	1268	11.9	13.2	—	2
1948–49	325	1169	12.6	8.4	1	1
1950–51	311	1101	12.4	12.8	—	2
1952–53	302	1119	22.2	20.2	2	—
1954–55	288	1007	28.4	23.1	2	—
1956–57	185	568	40.8	41.6	—	2
1958–59	183	524	53.6	51.7	2	—
1960–61	203	661	53.0	47.8	2	—
1962–63	227	789	47.4	43.2	2	—
1964–65	184	999	63.1	59.6	1	1
1966–67	120	390	44.1	46.6	1	1
1968–69	75	213	39.0	43.1	1	1
1970–72	32	76	42.8	19.4	2	1
Total	3005	10,385	30.6	27.8	18	11
1944–57	1981	7133	19.9	18.7	7	7
1958–72	1024	3252	51.3	47.7	11	4

*Number of workers with positive badge readings in each year.
†Mean annual radiation doses of exposed workers in centirads (AREW doses).
‡Number of years with higher doses for cancers than non-cancers or vice versa.
Note there are small differences in the totals for Tables 5–8 which are due to the time units being measured to the nearest whole year.

Table 6. Mean annual radiation doses for exposed workers (cancers and non-cancers) (employment years)

Employed years	Exposed workers* Cancers	Exposed workers* Non-cancers	Radiation doses* Cancers	Radiation doses* Non-cancers	High risk years* Cancers	High risk years* Non-cancers
0–1	463	1786	21.8	23.1	—	2
2–3	475	1747	15.6	16.8	—	2
4–5	368	1294	18.3	17.2	2	—
6–7	321	1162	24.5	22.7	1	1
8–9	273	985	34.4	28.3	2	—
10–11	232	811	41.9	33.1	2	—
12–13	164	528	47.5	44.4	1	1
14–15	171	521	54.9	47.8	2	—
16–17	171	541	47.2	45.6	1	1
18–19	144	461	46.5	43.1	1	1
20–21	103	294	53.3	52.4	1	1
22–23	73	160	40.3	32.0	2	—
24–25	35	74	27.0	21.7	2	—
26–29	14	22	14.4	16.1	1	2
Total	3007	10,386	30.1	27.8	18	11
Under 10 yr	1900	6974	21.5	21.1	5	5
Over 10 yr	1107	3412	46.3	41.7	13	6

*See footnotes to Table 5.

were equal numbers of high risk years for the two causes of death. When intervals from hire to exposure were longer than 10 yr (and AREW doses averaged 46.3 for cancers and 41.7 for non-cancers), there were twice as many high risk years for cancers (13) as non-cancers (6).

Pre-death years (Table 7 and Fig. 3)

The pre-death year classification showed that: (i) the proportion of exposed workers decreased with progressive shortening of the pre-death period, but the trend for AREW doses was in the opposite direction and (ii) in the middle of the time scale, the radiation doses were consistently higher for cancers than non-cancers but towards the beginning and end of the range, the radiation doses were frequently lower for cancers than non-cancers.

Each year the proportion of exposed workers remained a fraction higher for cancers than non-cancers (Fig. 3). However, when the interval between exposure and death was less than 8 or more than 20 yr (and AREW doses averaged 30.1 for cancers and 30.6 for non-cancers), there were over twice as many high risk years for non-cancers (12) as cancers (5). Between these extremes (when AREW doses averaged 31.0 for cancers and 25.1 for non-cancers), there was an unbroken series of high risk years for cancers (Table 7).

Exposure age (Table 8 and Fig. 4)

The exposure age analysis, which was restricted to men between 20 and 65 yr and to

Table 7. Mean annual radiation doses for exposed workers (cancers and non-cancers)

Pre-death years†	Exposed workers*		Radiation doses*		High risk years*	
	Cancers	Non-cancers	Cancers	Non-cancers	Cancers	Non-cancers
0-1	156	675	29.6	28.8	1	1
2-3	241	854	41.8	35.4	2	—
4-5	273	974	39.8	42.4	1	1
6-7	305	1015	37.1	39.1	—	2
8-9	310	1022	36.8	32.7	2	—
10-11	283	933	33.4	28.2	2	—
12-13	242	868	35.1	25.4	2	—
14-15	257	863	29.0	22.2	2	—
16-17	239	861	27.3	21.3	2	—
18-19	210	724	21.4	18.2	2	—
20-21	186	592	12.9	14.2	—	2
22-23	143	481	14.9	15.4	—	2
24-25	111	353	18.2	16.9	1	1
26-28	56	172	15.7	23.5	—	3
Total	3012	10,388	30.6	27.8	17	12
8-19 yr	1541	5271	31.0	25.1	12	—
Other yr	1471	5117	30.1	30.6	5	12

*See footnotes to Table 5.
†Interval between exposure and death (in yr).

Table 8. Mean annual radiation doses for exposed workers (cancers and non-cancers)

Exposure age in years†	Exposed workers*		Radiation doses*		High risk years*	
	Cancers	Non-cancers	Cancers	Non-cancers	Cancers	Non-cancers
20-22	11	22	25.2	13.8	2	1
23-25	21	99	11.4	21.4	1	2
26-28	55	172	25.9	25.9	1	2
29-31	93	272	22.3	30.0	—	3
32-34	111	419	14.4	30.9	—	3
35-37	150	536	19.7	23.8	1	2
38-40	160	609	20.9	21.3	2	1
41-43	224	665	25.8	24.9	2	1
44-46	233	744	28.9	26.4	2	1
47-49	253	777	37.6	31.9	3	—
50-52	281	876	33.7	30.7	3	—
53-55	265	930	34.3	26.0	3	—
56-58	235	863	30.7	25.3	2	1
59-61	196	708	28.4	24.5	3	—
62-64	160	527	34.5	24.2	3	—
Total	2448	8219	28.9	26.5	28	17
Under 35 yr	291	984	18.4	28.4	4	11
35-55 yr	1566	5137	30.0	26.8	16	5
Over 55 yr	591	2098	31.0	24.3	8	1

*See footnotes to Table 5.
†Excluding exposures before 20 yr of age, or after 65 yr, or within 5 yr of death.

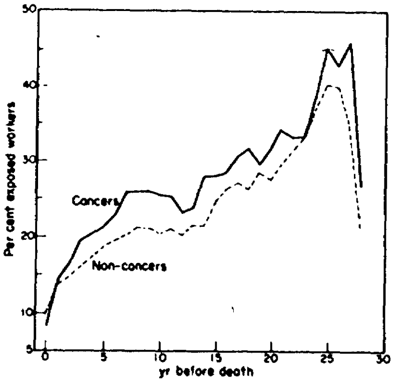

FIG. 3. Per cent of exposed workers by years before death cancer and non-cancers deaths of males.

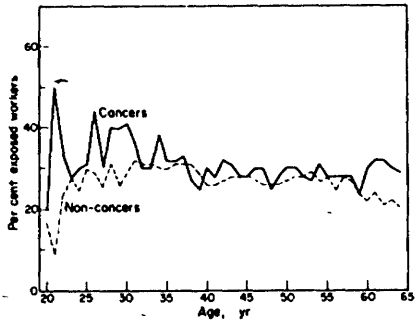

FIG. 4. Per cent of exposed workers by exposure age (excluding exposures within 5 yr of death).

exposures more than 5 yr before death, showed that: (i) the proportion of exposed workers was virtually independent of age (Fig. 4) and (ii) only after 40 yr were the radiation doses noticeably higher for cancers than non-cancers.

From 20 to 35 yr of age, there were more than twice as many high risk years for non-cancers (11) as cancers (4) and AREW doses were also higher for non-cancers (28.4) than cancers (18.4). However, for the group with initially high radiation doses there was a decrease with age (non-cancers) and for the group with initially low doses there was an increase with age (cancers). Therefore, by 40 yr the men who eventually developed fatal cancers were recording higher doses than the men with other causes of death. Thus, from 35 to 55 yr there were 16 high risk years for cancers and 5 for non-cancers, and from 56 to 65 yr the corresponding numbers were 8 and 1. In the younger of these two age groups the AREW doses were 30.0 for cancers and 26.8 for non-cancers, and in the older age group they were 31.0 and 24.3.

Age at death

With recurrent events as controlling factors (e.g. exposure years and exposure ages), there was no way whereby men who remained in the monitored population for short periods of time could contribute as much to the final results as men who remained for long periods and no way whereby the findings for each subgroup could be totally independent. However, with age at death as the controlling factor, there was no difficulty in obtaining strictly independent findings for any number of subgroups. Therefore, the analysis proceeded along new lines and was directed towards obtaining a stringent test of the null hypothesis of no correlation between the radiation dose and the proportion of cancer deaths after controlling for age at death (see Spearman's rank correlation coefficients in Table 11).

The basic data for this test were: (i) age at death for subgroups defined by cause of death (Table 9); (ii) radiation doses for subgroups defined by age and cause of death (Table 10); and (iii) cancers as a proportion of all certified deaths in groups defined by age at death and radiation dose (Table 11). Thus Table 9 shows that: (i) although accidents were often causes of early death, men who eventually developed malignant diseases did not have appreciably longer life spans than men with other causes of death and (ii) between two thirds and three quarters of all the deaths occurred between 50 and 80 yr of age.

Table 9. Age distributions of cancer and non-cancer deaths: stated causes of death (and I.C.D. Nos.)

Age at death in years	Cardiovascular (390–458) %	Respiratory; digestive (460–577) %	Accidents (800–999) %	Other non-malignant %	All non-cancers %	Cancers (140–209) %	All causes %
Under 40	2.6	5.1	30.0	12.6	8.0	3.7	7.2
40–49	11.9	12.3	27.3	11.7	14.4	12.8	14.1
50–59	25.3	20.7	21.6	27.0	24.4	27.9	25.0
60–69	29.0	32.5	16.2	23.9	26.9	35.7	28.6
70–79	23.4	24.9	4.2	17.8	20.1	17.3	19.6
80+	7.8	4.5	0.7	7.0	6.2	2.5	5.5
Totals:							
Nos.	1837	333	450	230	2850	670	3520
%	52.2	9.5	12.8	6.5	81.0	19.0	100.0

Table 10 Mean cumulative radiation doses for stated causes of death and stated age at death

	Mean cumulative doses (R) in centirads								Radiation dose Ratios*	
Age at death in years	Cardiovascular (390–458)	Accidents (800-999)	Other non-cancers	Solid tumors (140–199)	RES neoplasms (200–209)	All cancers (140–209)	All non-cancers (001–136; 210–999)	All deaths (001–999)	Ca: Non-Ca	RES: Solid
Under 40	59	47	76	55	40	52	56	55	0.93	0.73
40–49	95	114	104	100	37	93	102	100	0.91	0.57
50–59	157	133	64	187	329	201	136	150	1.48	2.19
60–69	132	116	125	145	82	140	129	132	1.09	0.62
70–79	46	24	72	60	787	103	51	60	2.02	13.12
80+	39	6	13	17	97	22	34	33	0.65	2.94
All ages	105	94	88	130	219	138	99	107	1.39	2.05

*Ca = Cancers; Non-Ca = Non-cancers; RES = RES Neoplasms; Solid = Solid tumors.

Table 11. Test for correlation between the percentage of cancer deaths and the cumulative radiation dose after standardization for age at death

Age at death in years	Mean cumulative radiation dose for all workers (in centirads)											
	Zero		1-19		20–99		100–499		500 +		Total	
	Nos	% Cancers	Nos	% Cancers	Nos	% Cancers	Nos	% Cancers	Nos	% Cancers	Nos	% Cancers
Under 40	108	9.3	55	10.9	58	8.6	24	8.3	9	22.2	254	9.8
40–49	185	13.0	82	15.9	137	21.9	74	23.0	17	11.8	495	17.3
50–59	331	19.3	137	16.1	200	24.5	155	21.9	58	31.0	881	21.2
60–69	360	22.2	162	21.6	248	26.6	184	25.0	53	22.6	1007	23.7
70 +	352	13.6	189	11.6	251	17.5	74	18.9	17	29.4	883	15.1
Total	1336	16.9	625	15.7	894	21.7	511	22.0	154	25.3	3520	19.0

	Ranking Nos for cancer proportions					Value of† rho
Under 40	3	4	2	1	5	0.1
40–49	2	3	4	5	1	0.0
50–59	2	1	4	3	5	0.8
60–69	2	1	5	4	3	0.5
70+	2	1	3	4	5	0.9
Means	2.2	2.0	3.6	3.4	3.8	0.46 ± 0.22*

*This value is statistically significant at the 5% level.
†Value of Spearman's rank correlation coefficient between the percentage of cancer deaths and the radiation dose level.

Table 10 shows that division of men who lived for more than 50 and less than 80 yr into three age groups still left each subgroup of cancers with a higher radiation dose than the corresponding group of non-cancers and still left each subgroup of RES neoplasms with a higher dose than the corresponding group of solid tumors.

Finally, Table 11 includes the results of the correlation test and shows that division of the certified deaths into 5 age groups and 5 dose levels still left the highest radiation dose groups (over 500 centirads) with the highest proportion of cancer deaths. As a result of this consistent trend, there was a firm rejection of the null hypothesis by the statistical test. Thus in three age groups Spearman's rank correlation coefficient (between the proportion of cancer deaths and the radiation dose level) had a value equal to or greater than 0.5 and the mean coefficient over age had a value of 0.46 ± 0.22. This is a statistically significant result since the coefficient for (n) observations has a variance of ($1/n - 1$). Therefore, for a mean coefficient from 5 age groups, each with 5 dose levels, the variance is (1/20) implying a standard error of 0.22.

SPECIAL TESTS OF THE RADIATION ASSOCIATIONS

The impression of a causal association between the exposures to external radiation and the cancer deaths was strengthened rather than weakened by the controlled analyses. Therefore it only remained to test the safety threshold hypothesis (i.e. the theory that below the maximal permissible dose radiation has no carcinogenic properties) against the only logical alternative, namely, that with any exposure to ionizing radiation there is a cancer hazard which is proportional to the dose.

The choice of statistical test was influenced by the following assumptions: first, the most plausible alternative to the safety threshold hypothesis is a dose–response relationship that is either linear or at least monotonically increasing. Secondly, in Hanford data the stimulus or radiation dose, is continuously variable and the response or development of a fatal cancer, is a binary one (or an all-or-nothing response). Therefore, the most appropriate statistical model was the logistic or log-linear one which states that the logarithm of the odds-ratio of a response is linearly related to the stimulus over a suitable range of intensity (Co70).

Under the assumptions of this model the most powerful test of the null-hypothesis was the permutation test of the difference between the mean cumulative radiation dose for men developing fatal cancers and the mean for all certified deaths. Therefore the test could be carried out in three stages:

(1) *Test for cancers with definite radiation associations*

Let N = size of whole population;

n = size of subpopulation of cancer deaths;

R = average value of radiation dose for the whole population;

r = average value of radiation dose for the subpopulation cancer deaths;

S = average value of the squared dose for the whole population.

Then, the estimate of variance in whole population $(V) = (N/(N-1))(S-R^2)$ and $t = [(r-R)/\sqrt{V[(1/n)-(1/N)]}]$ where this statistic is approximately distributed as a t statistic with $(N-1)$ ~~degrees of~~ freedom for testing the null hypothesis (see Appendix).

(2) *Quantitative estimates of radiation sensitivity (doubling dose)*

Should the null hypothesis of no associations between the radiation doses and the cancer deaths be rejected by the first test (as a result of t exceeding a critical value of approx +2.0), a quantiative estimate of radiation sensitivity would be required and could be obtained in the following way:

Let D = the radiation dose which is just sufficient to double the normal risk of a cancer death (doubling dose). Then r will have an expected value of $(R + S/D)/(1 + R/D)$ (see Appendix).

Therefore, by solving this equation with observed values of r, one could obtain for any cancer with definite radiation associations an estimate of the doubling dose (D).

(3) *Quantitative estimates of radiosensitivity in relation to pre-death years and ages*

There is no reason why the above formulas should not be used in relation to radiation doses for stated time periods or ages; and there are strong grounds for believing that: (i) tissue specific cancers have characteristic, albeit long, intervals between initiation and death, and (ii) sensitivity to the cancer-induction effects of any mutagen is strongly age dependent. Therefore, in Hanford data, the search for radiosensitive cancers can be directed towards discovering which of several pre-death years or ages (in relation to tissue specific cancers) are associated with statistically significant differences between observed and expected radiation doses (or t values equal to or greater than 2.0).

By taking this approach the identification of cancers with definite radiation associations (radiosensitive cancers) can be combined with estimates of: (i) the relative sensitivity of different tissues (as measured by doubling doses for the relevant cancers); (ii) characteristic intervals between initiation dates and death (or the pre-death years showing the maximum contrast between observed and expected radiation doses); and (iii) the ages of maximal and minimal sensitivity to the cancer-induction effects of ionizing radiation (or the ages showing maximum and minimum differences between observed and expected doses). Therefore, the search for radiosensitive cancers (and other diseases with radiation associations) was pursued, first in relation to pre-death periods (Tables 12–15), then in relation to age (Table 16).

Table 12. Cumulative radiation doses for stated pre-death periods

	Non-cancers Mean cumulative radiation doses in centirads			
Pre-death years[*]	All non-cancer[†] deaths	Cardiovascular diseases	Accidents	Other non-cancers
28	3.2	3.4	0.0	3.2
26	15.8	15.3	7.1	19.2
24	19.4	17.4	10.9	28.2
22	22.4	20.6	18.3	29.4
20	24.1	22.7	20.0	30.7
18	29.0	27.9	23.5	35.1
16	35.2	24.8	32.3	38.1
14	41.3	41.3	37.1	43.2
12	48.2	48.9	44.3	47.9
10	56.6	57.2	54.8	55.5
8	67.3	68.0	64.4	66.6
6	80.0	81.6	76.4	76.7
4	92.6	94.6	91.0	86.6
2	100.9	104.0	100.5	90.7
0	106.0	110.9	101.4	93.2
Number of deaths	2850	1837	450	563

[*] See footnote to Table 7.
[†] Standard values, see later tables.

Table 13. Cumulative radiation doses for stated pre-death periods

	Cancers		
Pre-death years[§]	All cancers	RES neoplasms	Solid tumors
28	1.9	0.7	2.2
26	12.5	24.6	11.5
24	18.9	14.3	19.3
22	22.7	23.1	22.7
20	25.2	33.0	24.5
18	34.0	*52.2*[*]	32.3
16	44.3	*83.0*[†]	40.6
14	*54.3*[*]	*105.2*[†]	49.1
12	*65.0*[*]	*126.0*[†]	58.8
10	*76.7*[*]	*154.0*[†]	69.1
8	*90.4*[*]	*175.4*[†]	81.7
6	104.2	*194.5*[*]	95.0
4	116.6	*200.9*[*]	107.7
2	129.0	*216.2*[*]	119.6
0	134.4	*223.1*[*]	125.0
Number of deaths	670	64	606

Figures in italics significantly differ from the standard values in Table 12.
Levels of significance:
[*] $P < 0.05$.
[†] $P < 0.01$
[‡] $P < 0.001$.
[§] See footnote to Table 7.

Table 14. Cumulative radiation doses for stated pre-death periods

Pre-death years*	Mean cumulative radiative radiation doses in centirads† Bone marrow (203; 205)	Other sites (200–2; 204; 206–9)
28	1.0	0.0
26	3.0	57.0
24	4.2	26.4
22	19.0	26.7
20	37.6	29.1
18	53.1	51.1
16	*121.6*‡	50.5
14	*180.5*‡	54.0
12	*231.1*‡	60.7
10	*310.2*†	63.4
8	*401.4*‡	62.3
6	*446.9*‡	65.0
4	*438.5*‡	72.9
2	*468.1*‡	90.3
0	*469.2*‡	100.1
Number of deaths	22	42

*See footnote to Table 7.

†See footnotes to Tables 12 and 13.

‡See significance levels in Table 13

Table 15. Cumulative radiation doses for stated pre-death periods

Pre-death years*	Solid tumors Mean cumulative radiation doses in centirads† Large intestine (153)	Pancreas (157)	Lung (162)	Kidney (189)	Brain (191)	Other solid tumors
28	0.0	12.0	4.0	1.0	0.0	0.0
26	8.7	12.0	15.0	2.0	40.0	6.3
24	19.1	25.6	18.4	1.3	39.2	17.8
22	27.9	33.6	23.3	2.6	36.5	18.9
20	25.7	35.9	25.0	3.0	46.9	21.2
18	45.2	35.9	35.3	13.7	59.3	25.8
16	54.7	48.2	45.7	24.9	70.7	30.9
14	63.1	65.5	*61.8*‡	35.9	70.8	32.2
12	74.3	90.1	*72.1*‡	74.8	93.7	35.3
10	92.3	*119.9*‡	86.9	88.9	98.1	37.7
8	106.5	*142.7*‡	103.4	98.1	124.8	43.9
6	125.1	*173.9*‡	117.1	123.6	158.4	49.4
4	129.6	*214.5*‡	132.6	159.9	193.9	54.1
2	137.0	*247.0*‡	147.5	172.7	226.8	59.1
0	141.8	*269.0*‡	153.4	171.3	233.4	62.6
Number of deaths	61	49	192	21	18	265

*See footnote to Table 7.

†See footnotes to Tables 12 and 13.

‡See significance levels in Table 13

*Table 16. Estimated doubling doses for critical pre-death years**

Radio-sensitive cancers	Critical pre-death periods Years before death	Estimated doubling dose in rads	Proportion of all deaths Observed %	Expected† %
Bone marrow	9	0.8	0.62	0.30
Pancreas	0	7.4	1.39	0.85
Lung	14	6.1	5.45	3.26
All RES neoplasms	11	2.5	1.82	1.15
All cancers	13	12.2	19.02	15.15

*The years before death which showed the maximum contrast compared with the standard group of all non-cancer deaths (see Tables 13–15)

†See U.S. Vital Statistics for deaths of white males (1960).

RADIOSENSITIVITY AND CRITICAL PRE-DEATH PERIODS

Division of the non-cancer deaths into several subgroups failed to produce any evidence of radiation associations in either the pre-death period or the age analysis (Table 12). For example, 12 yr before death the mean cumulative radiation dose for external radiation was 48.2 centirads for all non-cancer deaths (standard or control group). For cardiovascular deaths, the corresponding dose was 48.9 (case: control ratio 1.01), for fatal accidents 44.3 (ratio 0.92) and other non-cancer deaths 47.9 (ratio 0.99). There were, however, positive findings for all cancers and for some of the neoplasms with exceptionally high radiation doses.

Thus for all cancers (ICD Nos. 140–209), there were positive findings (i.e. significant differences between observed and expected doses of external radiation) over a period of nearly 10 yr, namely, 7–15 yr before death; and for RES neoplasms there were positive findings over a period of nearly 20 yr, namely, from 0 to 18 yr before death (Table 13). For bone marrow cancers there were exceptionally strongly positive findings for the period 0–17 yr before death (Table 14), and for 2 of the 5 solid tumors with high radiation doses some of the differences between observed and expected doses were statistically significant. Thus, for pancreatic tumors, there were positive findings for the period 0–11 yr before death, and for lung cancers there were similar findings for the period 11–14 yr before death (Table 15).

For all cancers the critical interval between exposure and death—or the period of maximum case:control contrast as indicated by the t value—was 12 yr (case:control ratio 1.35 and $t + 2.4$). For RES neoplasms the corresponding period was 11 yr (ratio 2.71 and $t + 3.7$), and for bone marrow cancers 9 yr (ratio 5.86 and $t + 6.1$). For lung cancers the critical interval was 14 yr (case: control ratio 1.50 and $t + 2.0$), and for pancreatic tumors under 1 yr (ratio 1.50 and $t + 3.0$).

For other cancers with high radiation doses, there was less certain evidence of a causal association. However, for brain tumors there was a period of 3 yr when observed doses were twice as high as expected doses and t values were greater than +1.5 (i.e. 17–19 yr before death), and for cancers of the large intestine the observed dose 18 yr before death was 58% above the expected dose (t + 1.3). Finally, there were two findings which suggested that, given a longer period of records, there might have been a wider range of radiosensitive cancers. As a result of the study being restricted to men who died before 1973, there were very few records of radiation exposures 26 yr before the final (death) year. However, in this rare group 3 cases of brain tumors recorded a radiation dose which was almost 3 times as high as the expected dose (t + 1.3), and 2 cases of lymphosarcomas recorded a radiation dose nearly 4 times as high as the expected dose (t + 1.8).

DOUBLING DOSES FOR RADIOSENSITIVE CANCERS

From the records for critical pre-death periods, estimates were made of the amount of radiation which would be needed to double the normal risk of developing any of the cancers with definite radiation associations (see doubling doses in Table 16). According to these estimates, 12.2 rads would be needed to double the normal risk of dying from any form of cancer. For cancers of pancreas or lung, the doses would be somewhat lower (7.4 or 6.1 rads) and for RES neoplasms or bone marrow cancers, they would be even lower (2.5 or 0.8 rads).

These suggested doses are so much lower than the estimates based on atom bomb survivors (Co70) that they are unlikely to go unchallenged. Therefore, we have included in Table 16 the proportions of certified deaths caused by the cancers with definite radiation associations, and the proportions of these cancers expected on the basis of all certified deaths of U.S. white males in 1960 (VSUS60). From these observed and expected proportions, standardized mortality ratios (SMRs) were obtained in the usual way and compared with the results of solving the following equation with observed values of D and R:

$$\mathrm{EMR} = 100 \times \left(1 + \frac{R}{D}\right)$$

where EMR = excess mortality from a radiosensitive cancer relative to a standard risk of 100 for all certified deaths.

According to the SMRs, the risks for Hanford workers were increased by 26% for all cancers, by 58% for RES neoplasms, and by 107% for bone marrow cancers (Table 17) and, according to the EMRs, the risks were increased by 4% for all cancers, by 21% for RES neoplasms, and by 79% for bone marrow cancers. Since the more conservative estimates were based on the doubling doses in Table 16, we are faced with two alternatives: either the actual doubling doses were even smaller than the estimates in this table; or, more likely, external radiation was not the only source of trouble for Hanford workers. In other words our analysis of the records relating to external radiation has shown the need for a similar analysis of the records relating to internal radiation.

Table 17. Excess cancer mortality of Hanford workers: Comparisons between conventional SMRs and estimates based on radiation doubling doses (EMRs)

Cancers with definite Radiation associations	SMRs*	EMRs†
Bone marrow	207	179
Pancreas	163	114
Lung	167	107
All RES neoplasms	158	121
All cancers	126	104

*See Table 16. (Standard = 100).
†See text.

INTERNAL RADIATION

The data relating to depositions of radioactive substances are not yet in a form suitable for testing the null hypothesis of no trouble from this potential source of radiation-induced cancers. It is, however, possible to distinguish between Hanford workers with and without positive urine analyses and thus discover whether the positive findings in Tables 13–15 were due solely to workers in high risk or doubly monitored occupations or partly to men in low risk occupations or ones which were only monitored for external radiation.

Division of the certified deaths into two groups (with and without records of internal radiation) showed that: (i) the proportion of cancer deaths was higher in the positive group (22%) than in the negative group (18%) (Table 18) and (ii) the all-worker dose for external radiation was much higher in the positive group (357 centirads) than in the negative group (23). However, even in the low dose group the external radiation dose was higher for cancers (29) than non-cancers (21), and in both groups a pre-death period analysis produced positive findings in relation to RES neoplasms (Tables 18 and 19).

In the high dose group there were 17 RES neoplasms and 7 bone marrow cancers, and in the low dose group there were 47 RES neoplasms and 15 bone marrow cancers. In the first of these two groups there were positive findings in relation to these neoplasms for 8 of the 29 pre-death years (Table 18), and in the second group there were positive findings for 5 of these years (Table 19). Also, for the period associated with positive findings in both high and low dose groups (i.e. 12 yr before death), the estimated doubling doses were not significantly different for the two occupational groups.

Table 18. External radiation doses of workers with positive and negative records of internal radiation

Internal radiation*	Diagnostic categories	Cases Nos.	Cases %	External radiation in centirads Total	External radiation in centirads Mean
Positive	Cancers	194	21.9	79,004	407
	Non-cancers	691	78.1	236,940	343
	Total	885	100.0	315,944	357
Negative	Cancers	476	18.1	13,653	29
	Non-cancers	2159	81.9	46,021	21
	Total	2635	100.0	59,674	23
Both	Cancers	670	19.0	92,651	138
	Non-cancers	2850	81.0	282,961	99
	Total	3520	100.0	375,618	107

*One or more depositions of radioactive substance.

Table 19. Cumulative doses of external radiation for stated pre-death years

	Men with positive urine analyses			
Pre-death years	Non-cancers	RES neoplasms	Lung and pancreas	Other solid tumors
28	13.7	—	27.6	4.9
26	21.5	57.0	35.5	13.8
24	28.4	26.2	29.2	26.2
22	36.7	53.2	49.1	31.5
20	47.2	89.2	59.9	37.0
18	59.4	159.1*	78.6	52.3
16	76.1	201.2*	114.4	73.7
14	99.9	243.3*	130.2	96.3
12	127.6	257.1*	172.3	135.0
10	158.4	300.1	224.8	174.4
8	198.2	312.5	269.3	212.1
6	245.2	376.8	323.8	260.7
4	292.1	396.2	379.1	302.5
2	324.6	407.6	409.5	335.9
0	380.3	418.7	460.4	381.1
Number of deaths	691	17	86	91

*See significance levels in Table 13.

Table 20. Cumulative doses of external radiation for stated pre-death years

	Men with no record of internal radiation			
Pre-death years	Non-cancers	RES neoplasms	Lung and pancreas	Other solid tumors
28	7.8	0.5	20.5	24.5
26	12.5	1.7	14.5	19.9
24	14.1	14.4	19.0	19.5
22	16.0	12.3	16.4	18.2
20	16.0	15.3	15.4	18.6
18	17.5	24.7	18.0	20.6
16	18.6	27.2	17.3	22.1
14	19.1	29.8	19.7	22.5
12	19.9	36.0*	22.2	25.2
10	22.0	42.0*	24.5	25.5
8	24.5	46.6*	29.2	27.2
6	27.1	46.3	30.9	28.2
4	29.3	46.4	34.6	30.1
2	31.8	49.9	34.7	32.5
0	40.1	51.7	36.2	39.7
Number of deaths	2159	47	155	274

*See significance levels in Table 13.

AGE AND SENSITIVITY TO THE CANCER-INDUCTION EFFECTS OF RADIATION

The search for sensitive age groups utilized a single set of controls (all non-cancer deaths) and two sets of cases, viz RES neoplasms and solid tumors with high radiation doses (see pancreas, lung, brain, kidney and large intestine in Table 3).

Towards the beginning and end of the age range of external radiation records (which covered the period between 21 and 78 yr), there was virtually no data for the smaller case group (RES neoplasms), but between 30 and 70 yr of age the records for this group were strongly suggestive of an exponential increase in cancer sensitivity with advancing age. Thus, between 30 and 40 yr of age the observed doses were consistently lower than the expected doses. However, by 45 yr the observed doses were 15% higher than the standard dose; and by 50 yr they were 50% higher. These differences were not statistically significant, but by 55 yr there was a threefold difference between the observed and expected doses ($t + 2.5$), and by 70 yr a 14-fold difference ($t + 9.2$).

For the larger case group, there were positive findings at both ends of the age scale and a lull period between 25 and 40 yr. Thus, in

*Table 21. Mean cumulative doses of external radiation by stated ages: Non-cancers, RES neoplasms and other selected cancers**

Age in years	Non-cancers R†	RES neoplasms R	RES neoplasms t‡	Other cancers* R	Other cancers* t	Nos. of observations Non-cancers	Nos. of observations RES Neoplasms	Nos. of observations Other cancers
21	8	—	—	39	2.3	43	1	6
22	7	2	—	39	3.1	87	2	7
23	9	7	—	47	3.2	118	3	7
24	13	11	—	40	2.1	145	3	9
25	19	11	—	34	—	177	3	12
30	38	37	—	40	—	353	13	43
35	51	39	—	42	—	623	22	85
40	56	35	—	48	—	870	30	126
45	59	68	—	66	—	1093	34	175
50	73	116	—	105	2.0	1302	33	205
55	83	230	2.5	154	3.2	1397	30	213
60	80	211	2.0	130	2.1	1326	25	169
65	76	458	5.3	132	2.0	1072	15	112
70	48	701	9.2	80	—	716	8	59
71	43	701	9.9	89	—	645	8	52
72	43	34	—	98	2.7	587	5	40
73	38	34	—	100	3.5	521	5	29
74	37	35	—	98	3.1	454	4	25
75	36	45	—	98	2.8	386	3	22
76	35	45	—	115	3.3	338	3	16
77	35	45	—	112	3.0	278	3	15
78	37	68	—	119	2.5	231	2	10

*Cancers of the pancreas, lung, brain, kidney, and large intestine (see Table 3).
†R = Mean cumulative dose of external radiation.
‡t-values greater than the critical value of 2.0.

the youngest age group (21 yr with 6 cases and 43 controls), the observed and expected radiation doses were 39 and 8 ($t + 2.3$). In the next three age groups (22–24 yr), differences between observed and expected doses remained statistically significant, but from 25 to 45 yr there was nothing to choose between the observed and expected doses. Thereafter there was a steady increase in the cancer: non-cancer contrasts and by 60 yr the observed dose was 63% higher than the expected dose ($t + 2.1$). Finally, by 72 yr there was a twofold difference between the observed and expected doses ($t + 2.7$), and by 78 yr a threefold difference ($t + 2.5$).

These findings were suggestive of greater sensitivity to the cancer-induction effects of radiation in early and late adult life than during the intervening period and this impression was re-enforced by doubling dose estimates for various ages (Table 22). These estimates were also based on RES neoplasms and solid tumors with high radiation doses, and they showed that (i) for men between 25 and 40 yr of age the exposures to external radiation probably had no delayed effects; (ii) for older men the doubling doses decreased rapidly with age; and (iii) for younger men the trend was probably in the opposite direction.

*Table 22 Estimated doubling dose for stated ages: RES neoplasms and other selected cancers**

Age in years	Estimated doubling doses in rads RES neoplasms	Estimated doubling doses in rads Other selected cancers†
21	—	0.2
22	—	0.1
23	—	0.2
24	—	0.4
25	—	1.5
30	∞	49.2
35	∞	∞
40	∞	∞
45	30.0	70.4
50	13.0	17.9
55	6.2	14.6
60	6.8	18.3
65	1.2	14.8
70	0.1	16.0
71	0.1	8.7
72	—	2.5
73	—	1.1
74	—	1.1
75	—	1.2
76	—	0.8
77	—	0.9
78	—	0.9

*See Table 21 for the number of cases for each estimate.
†Cancers of the pancreas, lung, brain, kidney, and large intestine.

Females

Certified deaths of female workers totalled 412 and included 126 or 31% of cancers. The proportion of these workers with records of external radiation was small compared with the men and equally small for 127 women whose deaths were ascribed to cancers and 285 women with other causes of death (30%). Nevertheless, within the group of exposed workers the mean cumulative radiation dose was twice as high for cancers (133) as non-cancers (68).

Division of the cancer and non-cancer deaths of females into 4 age groups (Table 23)

Table 23. Cancer and non-cancer deaths of females by age and radiation dose

Age at death	Radiation dose levels (centirads)	No. of deaths (N)	No. of deaths (C)	%*	Cancers Rank	rho†	Radiation doses in centirads: Totals (N)	Totals (C)	Means for exposed workers (N)	Means for exposed workers (C)
20–49	0	71	35	33.0	(2)					
	1–	24	11	31.4	(1)					
	50–	4	3	42.9	(4)					
	100+	2	1	33.3	(3)					
	Σ	101	50	33.1		0.6	1071	564	33	38
50–59	0	31	30	49.2	(3)					
	1–	10	5	33.3	(2)					
	50–	6	2	25.0	(1)					
	100+	3	4	57.1	(4)					
	Σ	50	41	45.1		0.2	1190	2172	63	197
60–69	0	46	13	22.0	(2)					
	1–	9	1	10.0	(1)					
	50–	5	2	28.6	(3)					
	100+	6	3	33.3	(4)					
	Σ	66	19	22.4		0.8	2451	1372	123	229
70+	0	52	11	17.5	(2)					
	1–	11	—	0.0	(1)					
	50–	4	4	50.0	(3)					
	100+	1	2	66.7	(4)					
	Σ	68	17	20.0		0.8	1085	927	68	155
All ages	0	200	89	30.8	(2.25)					
	1–	54	17	23.9	(1.25)					
	50–	19	11	36.7	(2.75)					
	100+	12	10	45.5	(3.75)					
	Σ	285	127	30.8		0.60‡ ±0.29	5797	5035	68	133

*% of all certified deaths
†See Table 11.
N = Non-cancers
C = Cancers
‡This is a significant finding at the 5% level.

showed that: (i) radiation dose levels were always higher for cancers than non-cancers; (ii) cancer: non-cancer contrasts were greater for deaths after 50 yr of age than for earlier deaths; and (iii) in three age groups the proportion of cancer deaths was highest for the top level of radiation dose (over 100 centirads).

Finally, despite the small numbers of female workers with records of external radiation, the null hypothesis of no correlation between the radiation dose and the proportion of cancer deaths after controlling for age was rejected by a correlation test. According to this test, 3 of 4 Spearman's rank correlation coefficients (between proportions of cancer deaths and radiation dose levels) were equal to or greater than 0.6 and the mean coefficient over age had a value of 0.60 ± 0.29 (which is significant at the 5% level).

Estimates of the number of cancer deaths attributable to external radiation

In the final stages of the analysis, the best estimatés of risk were used to discover how many of the cancers with records of external radiation (442 cases) were attributable to these exposures (Table 24). For 14 bone marrow cancers, the estimated number of radiation-induced cases was 9.3, and for 161 cancers of the pancreas or lungs, the estimate was 18.6. The estimate for all cancers (25.8) was a fraction smaller than the sum of the estimates for the three cancers with definite radiation associations (27.9), and the estimate for all RES neoplasms (11.1) was a fraction larger than the estimate for bone marrow cancers (9.3). Therefore, the proportion of radiation-induced cancers among the exposed cases probably lay between 6 and 7%, and the corresponding proportion for all certified deaths probably lay between 1% and 2%.

*Table 24. Estimated frequency of radiation-induced cancers among certified deaths of Hanford workers**

Certified causes of death	Exposed workers Nos	Radiation-induced cancers Nos.	Radiation-induced cancers %
Bone marrow	14	9.3	69.3
Pancreas	31	6.0	19.4
Lung	130	12.6	9.7
RES neoplasms	47	11.1	23.6
All cancers	442	25.8	5.8
All certified deaths	2184	25.8	1.2

*Provisional estimates for deaths during the period 1944–72.

DISCUSSION

A preliminary analysis of the records relating to external radiation has shown that there is sufficient data in the Hanford study to: (i) identify some of the more radiosensitive cancers; (ii) quantify the radiosensitivity of these neoplasms; (iii) obtain estimates of characteristic intervals between initiation and death; and (iv) recognize the ages of maximum and minimum sensitivity to the cancer induction effects of radiation.

Further analyses will be needed to rule out the now remote possibility that the positive findings were merely the result of the radiation exposures having associations with other cancer-related factors. These analyses will proceed in two directions. First, there will be joint standardization for all the factors with known or suspected radiation or cancer associations (e.g. exposure age, interval between hire and exposure, intervals between exposure and death, and depositions of radioactive substances). Secondly, there will be an extension of these analyses from non-survivors with certified causes of death to other members of the monitored population, or workers who are still alive at the time of follow-up.

Meanwhile cursory inspection of the records relating to men who were still alive in 1973 (Table 1) has shown that one of the reasons why the doses of external radiation have always been higher for survivors than non-survivors (Ma74) is because the survivors include a disproportionately large number of men with positive urine analysis (Table 25). This bias is due to an association between high risk occupations and young recruits, which has caused the proportion of young recruits to be different for: (i) singly and doubly monitored occupations; (ii) men with positive and negative urine analyses and (iii) survivors and non-survivors.

Since workers with positive urine analyses were more often and more intensively exposed to external radiation than other workers (Table 18), it is essential, when comparing survivors with non-survivors, to include internal radiation among the controlling factors. This necessity is clearly seen in Table 26 where 5 sets of standardized radiation doses are shown for 3 groups in Table 1 (survivors, non-cancers and cancers). For instance even controlling for two factors simultaneously (i.e. exposure year and cohort), still left the survivors with a higher dose (127) than the non-cancers (79) or the cancers (94), but when internal radiation was added to the other controlling factors, the standardized dose was not only lower for non-cancers (84) than cancers (112) but also lower for the survivors (101) than cancers.

Table 25. Age distributions of men monitored for internal and external radiation

Age at hire in years	Doubly monitored* (A) %	Doubly monitored* (B) %	Singly monitored* %	Survivors† %	Certified deaths %
Under 30	54.8	49.1	41.1	55.8	13.1
30-39	28.1	26.4	28.4	28.6	24.5
40-49	3.2	12.4	17.7	11.7	31.0
50-59	3.7	10.8	10.2	3.6	25.4
60+	0.2	1.3	2.6	0.3	6.0
Σ Nos.	12,095	3716	9128	21,206	3520
%	48.5	14.9	36.6	85.0	14.1

*Doubly Monitored = Monitored for internal and external radiation.
A = Positive urine analyses.
B = Negative urine analyses.
Singly monitored = Only monitored for external radiation.
†See Table 1.

Table 26. Standardized radiation doses of survivors and non-survivors in relation to various controlling factors

Controlling factors	Standardized radiation doses* (1)	(2)	(3)
Nil	156	63	81
Exposure year (E)	142	71	87
Cohort or year of hire (C)	138	72	90
E + C	127	79	94
E + C + internal radiation	101	84	112

*Standard (100) = External radiation doses recorded by the 1973 Survivors and certified deaths in Table 1.
(1) = 1973 Survivors.
(2) = Non-cancer deaths.
(3) = Cancer deaths

Nevertheless, the absolute doses were higher for the men who were still alive in 1973 than for the non-survivors included in the present investigation, and for Hanford workers as a whole, the trend of radiation doses (and proportions of exposed workers) is in an upward direction. Therefore we should be prepared for future analyses of Hanford data to show both a wider range of cancers with definite radiation associations (due to better representation of cancers with long latent periods) and a higher proportion of radiation-induced cancers among the exposed workers.

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APPENDIX

PROOFS OF STATISTICAL FORMULAE

(I) *Optimality of tests of mean doses in a linear logistic model* [after Cox (Co70)]

The assumed model is given by:

$$\ln\left(\frac{p_i}{1-p_i}\right) = \alpha + \beta x_i$$

where:

p_i = probability of individual i developing cancer;
x_i = dose of individual i; and
α and β are parameters (β for the effect of dose).

Then the log-likelihood is given by:

$$L = \sum_i z_i(\alpha + \beta x_i) - \sum_i \ln(1 + e^{\alpha+\beta x_i})$$

where:

$z_i = 1$ if individual i develops cancer, 0 otherwise, so $L = n\alpha + nr\beta - \sum_i \ln(1 + e^{\alpha+\beta x_i})$ in terms of n and r (defined in text). Since the only random variables occurring in this equation are n and (nr), they are jointly (and in fact individually) sufficient for α and β. Therefore by the principle of conditional test construction known to be optimal in such exponential type distributions, the best test of $\beta = 0$ is based on the distribution of (nr) given n and the set of values x_i. Evidently this is the permutation distribution of the mean of a sample of n from a population of size N, and this reduces by standard arguments to the t-test described in the text if N is sufficiently large and the distribution of the set x_i is suitably regular.

(II) *Estimation of the doubling dose in a linear model*

The assumed model is given by:

$$P\,\{\text{cancer}|\text{dose } x\} = A(1 + x/D)$$

where A = spontaneous cancer rate and D is defined as in the text. Let $P\{\text{dose } x \text{ in whole population}\} = f(x)$.

So that R (defined in text) $= \int_0^\infty x f(x)\,dx$.

Then, by Bayes theorem:

$$P\{\text{dose } x|\text{cancer}\} = \frac{A(1 + x/D)f(x)}{\int_0^\infty A(1 + x/D)f(x)\,dx}.$$

Evaluating r (the mean dose given cancer) from this formula, and simplifying, one arrives at the formula quoted in the text, since:

$$r = E\{x|\text{cancer}\} = \int_0^\infty x P\{\text{dose } x|\text{cancer}\}\,dx.$$

(III) *Validity of normal theory approximation for the* t-*value distributions*

The question whether the radiation dose distributions were sufficiently regular for the standard

t-test to apply) was answered by estimating the empirical distributions of the t-values by Monte Carlo simulations. In 1000 simulated random samples of size $n = 22$ (corresponding to bone marrow neoplasms) from the distribution of doses of $N = 3520$ certified deaths, only 6 random samples had t-values equal to or greater than 4.48 (or the actual t-value for the sample of bone marrow neoplasms). Thus the empirical probability is $P < 0.060$ compared with a theoretical value (based on a normal theory approximation) of $P \leq 10^{-4}$. A similar experiment with $n = 48$ (corresponding to pancreatic tumours) gave an empirical probability (to the t-value of 2.99 for pancreatic tumours) of $P < 0.010$ compared with a theoretical value of $P < 10^{-3}$. Thus in neither case is the probability increased so much as to give a false conclusion at the 1% level of confidence.

Mr. ROGERS. Thank you very much, Dr. Mancuso. I wonder if you could tell us briefly the results of your study. I think it would be well first, before we get into questioning, if you could describe for us the findings of your research.

Dr. MANCUSO. Dr. Stewart, would you do that?

Mr. ROGERS. Dr. Stewart?

Dr. STEWART. Would I have time to give a little background?

Mr. ROGERS. Certainly.

Dr. STEWART. As the data were available to myself and my statistical colleague, effectively, the followup of workers in the Hanford facility was synchronous with the followup of the atom bomb survivors in Japan, but instead of the workers in the Hanford industry receiving all of their radiation in one dose at the beginning of the followup period, the Hanford workers received it in very small dollops over time, and only in very recent years has this been appreciable. In other words, it has been a sort of creeping increase to the workers, though they are all still well below what would have been regarded as perfectly safe.

There was one other difference between the two populations. One started with a very high death rate because of all of the trouble from the holocaust, and is currently enjoying possibly a subnormal death rate, but ran for many years with this high death rate during the period in which results were coming out, the Hanford population has always prided itself on having a low death rate because it only admits to the work people who have to pass a certain medical examination. Then there is one other thing. In the Hanford works, the delegation of young and old workers to different occupations appears from our analysis to be such that the younger workers tend to go into the more dangerous occupations, that is to say, the occupations associated with the higher doses of radiation, and the older workers tend to go into the safer or low dose occupations.

Mr. ROGERS. May I just ask, whether they would they normally be assigned those positions, or would that be by choice?

Dr. STEWART. Presumably they are assigned and I would not—we are not in a position to know how they are assigned, but this is a feature of the data that we have examined, that in fact, consciously or unconsciously, young men have been drafted into the high dose occupations, middle-aged men into middle ones, and the older men into the light ones. This is a finding of our analysis. Now, I say all of this because during the period following 1944, very many of our ideas about the effects of radiation and cancer have emanated from the experiences of the atom bomb survivors. Now, I remind you they had all of their radiation at the beginning, and therefore one was observing the effects at stated subsequent periods of time, which related to the latent period of different forms of cancer. But with the Hanford population, you would start with very low doses and you wouldn't really notice anything, until number of years had passed.

I say this because it has the background of deciding that the standards of reference coming from the atomic bomb population have made it very difficult for people to appreciate the nature of the negative findings that were coming out of this Hanford survey before we had anything to do with it.

The most important and obvious finding for many years was, the live workers had higher radiation doses than anyone who died, and at first sight this is a very comforting sort of impression to have, because it could even lead you to think that a little radiation did you good, but of course it could be a misconception, due to the fact that if you are moving forward in time, as it were, with the Hanford workers, you were automatically getting into the death category, for the older people whom, as we have ascertained, were in safer occupations.

I think, therefore, a climate of opinion had built up that there was in fact—that we were dealing with a safe industry. I know that statements in Britain parallel often statements in America, and have rather conveyed that idea, that it was a very safe occupation.

So, there was this, and naturally enough, these impressions were gained from this industry from the contrast it appeared to offer from the atom bomb population. I think this could be related to what obviously was the reaction to the Milham finding. It was disappointing, to say the least of it, and it was therefore thought possibly wrong, because it was running counter to the previous experiences, the impression of the industry itself, and it was certainly running counter to the experiences of the atom bomb, which—I should fill you in—have always found—from this experience, there has been no doubt at all that there has been a connection between radiation and leukemia. This was the first and most obvious finding.

Gradually, as time has gone on, people have realized that this relationship between one form of cancer and radiation has spread to other forms of cancer. There are certain cancers recognized and now you could identify a whole group of different types of tumors that are emerging from this population as time passes.

Another thing that has been happening, if you study the literature of this population, progressively, the definition of what is low level radiation or the level of radiation that is likely to cause cancer trouble is dropping, dropping, dropping. In the very early days, it was thought that there was going to be no trouble under 100 rems. I think now it is recognized there will be some trouble at almost every level of dose. It gives you some insight into the slanted impression everyone was getting about radiation and its risks in the industry, because naturally the atomic bomb Japanese population were the only big population. But you see, silently, in a curious sort of way, an American population had been kept under observation for exactly the same time and what is happening is a curious contrast. It was obvious that certain relationships were coming out early in the atom bomb population, related to these very high doses that they got instantly which were never, of course, repeated in the Hanford industry.

In contrast to that, you get a feeling of apparent safety for a long period of time, as in the Hanford atomic facility and then, just when everyone is settled down to thinking it is really safe, there begins to appear some signs of trouble. I think it is probably true that the outsider is more alerted to this trouble, because, in a sense, they are not taking sides, than some in the industry who are hoping, hoping against hope, that the workers are not exposed to danger, because no one wants anybody to be at risk.

Hence, I think, George Kneale and I agree strongly with Dr. Milham that the text of the Gilbert report is in curious contradiction to the table. In other words, the tables support Milham and add something more about dose, and whereas the text rather makes out that there is no definite effect.

Well, I think I should now say that in spite of the apparent differences of opinion that have arisen, either from our own survey findings or from people examining the same data, either as a direct sort of criticism of what we did, because they had independent access to the data, everyone is in general agreement that there are at least two forms of cancer that are appearing too prominently among these workers.

You may now argue that they have swapped these deaths for another source of deaths, and so on. This depends on your position, but I think there is general agreement today that one of the cancers that arises from bone marrow, which has always been realized to be particularly sensitive to the effects of radiation, namely, multiple myelomatosis occurred too frequently in Hanford workers. Let's not make too much of it. There are very few of these deaths, but it is naturally a very rare cause of death, and it is obvious even with these few numbers that there are too many.

The other in which there is general agreement that there is an effect—the latest report by Dr. Land and Dr. Milham and our own survey is that the pancreas cancer is involved. Of more consequence in nature is whether or not lung cancer is involved. We in our update think that it is rather like the atom bomb study now, that the number of cancers is gradually enlarging the longer the time that you handle it.

So, if I could now just come back to how we ever came to have any say in this matter, a long way off from England. It so happens that I was strongly associated with an early discovery of a low-level radiation effect. This is almost exactly 20 years ago today, to the day, when we discovered as a result of comparing children who had died from cancers with live children and the same age and sex, we discovered that if they had been exposed in utero—the unborn child had been exposed to a very small quantity of radiation required to take a photograph to see if the baby was in the correct position, what we call obstetric radiography—that this event had been recorded more often by the children who died of cancer than by the live children. Certain calculations led to us suggesting, curiously enough, that about 5 percent of the cancers in this group had been caused in this way.

You will note we left 95 percent unexplained. Overnight, the definition of low-level radiation came down from under 100 rems to under 1 rem as a result of this, but for a long time there was difficulty in substantiating this finding. I cannot go into the reasons for this, but at the end of 20 years we emerged with the fact that there really was no mistake, that this was so, and is a risk.

So, people who do not like it have always said, the unborn child must be very special, and this risk does not apply to people of adult age. Now, this could be true, because one of our findings is that age is very important in this story. That is how we came to be here, and that is why I think it is true to say that we have had firsthand experience of the sort of day-to-day problems that occur in relation to the nature of the danger you are handling, the nature of the statistical tests you must apply, and the interpretation of these findings, to such an extent that rather elaborate statistical programs have been made. George Kneale has had an opportunity to become familiar with the ins and outs of this complicated statistical data.

Methods are invented by clever Americans, but opportunities to apply them to human data have been few and far between, and our survey in England did provide such an opportunity, and thus it was that Dr. Mancuso asked us to come over.

Well, I may tell you that we have been on the job now for just about 18 months, and it has taken us 18 months minus about 3 days to discover that really we still keep adding to the number of catches in the differences between the live and the dead people. But we are now perfectly satisfied that it is possibly due to the assignment of the younger men into the more dangerous occupations, and therefore they will only emerge in Hanford death data in the future, but they will be there eventually.

In the meantime, what have we been able to do by comparing cancer deaths with noncancer deaths, is to take advantage of the fact that for every man in this industry there was a record of how much radiation had been recorded on a badge for every year they worked in the industry, and incorporating that in a statistical analysis. This is a very rare situation and though the statistical method is a very unfamiliar method, it is, nevertheless, capable of proof that it was the correct method. The alternative, which many people said we ought to have done, or the alternatives, are in fact less sensitive methods, and might leave you for the next 10 or 20 years with negative answers or doubtful answers.

If you apply that method, we came up with what, after all, was not in a sense a new finding. It was further confirmation, but of a very special sort, of the original Milham finding which he had done by the proportional mortality study and which we maintained was reconfirmed when the proportional mortality was linked to the dose by Gilbert.

We know that at least one other person has had an opportunity to apply an alternative method to our same set of data, and has come up with the definite evidence of a myeloma and pancreatic tumor effect, but added the codicile that it could be a fluke. It could be two flukes.

Because of the strong criticisms of this finding, we have had an opportunity to update it on a larger sample of dose, and to institute more careful checks for what in our jargon is known as control procedures, making quite sure that you are not confusing the effects of any radiation received by the dose to the badges' penetrating radiation, not confusing it with other features of other experiences of the men, the time they were exposed, whether they had internal radiation, how old they were when they died, that sort of thing.

We have had time to institute much more careful checks on this, and in one word, the checks have shown that we certainly have not exaggerated the risks the first time around.

To give a simple figure, we gave as an estimate of the number of men in the initial analysis, that there was no trouble we said, from lung cancer deaths at that time, and we couldn't find anything. But as soon as you came to total cancers, the overall effect had been between 6 and 7 percent of the men had probably died from an occupationally induced cancer, a radiation-induced cancer.

Our revised estimate, on a somewhat bigger sample, under more safeguards and so on, says that it is almost exactly 5 percent. Just for people to realize what this means, we had 743 men who died from various forms of cancer, and we estimate that in this population there were 35 extra radiation-induced cancers.

We also can tell you that all of those extra cancers were concentrated in tissues that are known from animal experiments and previous work to be the tissues that are sensitive to the cancer induction effect of radiation. In other words, there is nothing absurd about the finding. It all follows logically. The only shock is that there were any, that there was any effect.

Mr. ROGERS. Thank you very much, Dr. Stewart.

May I ask, now, about your findings? Of course, you have done other epidemiological work in radiation, and I believe you were the one, as I understand it, and I think you just told us briefly about it, who determined that X-ray exposure of pregnant women could affect the child. Was that the current scientific view at the time that you made this finding?

Dr. STEWART. It had almost the same shock-like reaction as the current finding, and in fact was considered among epidemiologists to be a bit of a jackpot, but it then fell into disrepute because when people tried to repeat this finding by applying a different method—once again, we had taken a slightly unusual approach, but often things are found that way. It fell into disrepute because ever so many people found negative findings, but it has emerged after 20 years as being a genuine finding. It has taken on in Europe, Australia, and in most parts of the United States. It is accepted that there is not only a radiation risk from these photographs but that it has been able to tell us quite a lot about childhood cancers that we otherwise would not have been able to learn.

So, there is some basic research value in this sort of work.

Mr. ROGERS. The point I am wondering about is if you were criticized at the time for your findings.

Dr. STEWART. Certainly, certainly. We had great difficulty getting any support to continue. History repeats itself.

Mr. ROGERS. Yes. Thank you. Dr. Carter?

Mr. CARTER. Thank you, Mr. Chairman.

Doctor, could you describe your research relationship with AEC and ERDA before and after March, 1975, when you were verbally informed that your project would be transferred?

Dr. MANCUSO. Yes, sir. Briefly, all during the years when the progress reports were negative, I think the most cordial relationships existed. I think after Dr. Milham's finding of the summer of 1974, and the sequence of events afterwards, I would say that it is my distinct feeling that the relationships were changed. Certain events occurred which made me feel that way.

Mr. **Carter**. What were these events?

Dr. **Mancuso**. One in particular which I was very much put out about was the fact that one of the staff persons at ERDA had over my specific objections commanded and requested that a copy of my computer data tapes at the Oak Ridge Data Collection Center be sent to someone, a statistican at the National Cancer Institute.

I had previously indicated in a letter to this particular person that we would be willing to listen and consider certain possibilities, but after that event occurred, in which they overrode me with what I consider governmental interference with this research project at that point in time, I then refused to have anything to do with them.

Mr. **Carter**. Were you somewhat shocked to hear from them, even though you did not contemplate doing such, that you were supposed to resign at age 62?

Dr. **Mancuso**. Yes. I don't think Dr. Liverman helped me in any way with regard to that. I think it was most unfortuante that he should choose arbitrarily to decide that particular point. He had ample opportunity as did his staff in their decisionmaking process to make a telephone call to the university, or write a letter.

Subsequent interviews with Dr. Liverman have revealed that he did not in fact contact the university with respect to determining what the policy was. At the University of Pittsburgh you can continue on to the age of 70, a research professor could, as long as you brought in your own salary for yourself and your staff, and that is the way it has been ever since I have been with the university. I think that was most inappropriate, and I do not think that was the real reason. It was the reason they offered, but as far as I am concerned, I do not think it is a valid reason.

Mr. **Carter**. You had not stated to anyone that you meant to retire at age 62?

Dr. **Mancuso**. The point of the matter was, they never consulted me in the summer of 1974 and the deliberations as to what went on in the in-house deliberations between Dr. Liverman and the staff, which was at the same time considering the positive findings that Dr. Milham had come up with, and at the same time considering the dilemma that the Oak Ridge Associated Universities were in, in which they had a need for funs. They had not consulted me in any way in summer of 1974.

At the staff meeting in March of 1975, I recall very distinctly a conversation with Dr. Sidney Marks at that time. If the word "retirement" was mentioned, it was mentioned purely in passing. The entire structure and nature of the argument was, it was an administrative decision. Whatever the administrative decision meant, that is another story, but even at that time the subject of imminent retirement as far as I am concerned was not advanced.

Mr. **Carter**. Do you not think that this mention of your imminent retirement was the direct result of your findings and the findings of Dr. Milham at Hanford?

Dr. MANCUSO. I think it was a direct effect of Dr. Milham's findings. Mine were not known at that point in time. The option existed for Dr. Liverman and his staff from September on in the last year of my project to modify their administrative decision. I was very much at a loss to find out why—it was so inconvenient and inappropriate for them in view of the fact that we had reached this critical stage of analysis. We had designed and developed the project since 1964 and brought it to this point, as independent investigators. Why now they did not think it was appropriate to have us continue is beyond me. The excuses they are advancing now are not valid. I am perfectly willing to refer to them, but I do not accept them. They were never sent to me. I never received any "peer reviews," and all of our projects were funded year after year, and you can't fund a project unless you have a favorable peer review.

If there was any desire by AEC or ERDA to terminate this project based upon any adverse professional effort upon myself or the staff, it would have been most appropriate for them in this research contract to have notified me in a written order.

Mr. CARTER. Yes, sir, but when your findings began to show that there was an increase of radiation-asssociated cancer deaths, was that when your project was changed? Was that when the decision was made for your project to be phased out and sent to Oak Ridge?

Dr. MANCUSO. The time sequence was that the AEC can correctly state that prior to March of 1975, they did not know. They knew of positive findings relative to Dr. Milham, but also we found positive cancer findings in the summer of 1976. Yes, it was in 1976, that I notified ERDA headquarters. I do not know whether the first notification was in July, August, or September. I notified them of the findings, and I set up a plan to present these findings in a preliminary way in a 10-minute presentation at a Health and Physics Society meeting in October of 1976 in Saratoga, because I wanted to make sure that the warning of the identification of positive finding was made known.

I made arrangements and went down to see the ERDA staff on October the 4th of 1976, prior to the time that we made the Health Physics Society presentation, in order to advise them of the findings. At that particular point in time, though Dr. Stewart was with me at the time, and we were all there, with George Kneale, prepared to provide them, and we did provide them with all of our findings, nevertheless, the nature and extent of the conversation was more in the tone of, well, yes, you can publish the data, you have the right to publish the data, and we have no way of restraining you from publishing the data, but it would really be more helpful if, of course, continued study was done upon this, and if you did not rush into publication relative to these findings.

Mr. CARTER. Doctor, you stated you have been repeatedly urged by AEC and ERDA to publish negative progress reports. Is that correct?

Dr. MANCUSO. Yes.

Mr. CARTER. Who urged you to do this and why?

Dr. MANCUSO. The contract officer urged, on the basis, that this would make it more possible for the succeeding research grant to come about. I did not accept that reasoning tendered because I was very much concerned about the fact that the so-called negative findings were actually false negative findings, in view of the fact that they had not met two criteria.

One was the latent period relative to the induction of cancer, and second the time required to develop the data. What has not been recognized, and I have it in the overall text which you have, is that actually the date on which I received certain data was very late. This is made clear, on page 19 of my detailed testimony. On September 23, 1976 the external radiation pertaining to the population in 1944 and 1975, was transmitted to me; on November 2, 1975, the external radiation data in 1944 to 1974, was transmitted. Then the internal radiation was not transmitted to me at all until March 31, 1976.

Then, the environmental data, exposure records related to job, craft, occupation, and hazard categories, were never submitted to me until March 10, 1977, then the employment relative work history data kept changing all the time, and the latest data we got on that was June 28, 1976. So it was difficult for several reasons, but primarily, I believe that the data would be a false negative, and I would not go along with that, no matter whether I risked the project or not.

Mr. **Carter**. What was the name of your contract officer?

Dr. **Mancuso**. Dr. Sidney Marks.

Mr. **Carter**. What group was he with?

Dr. **Mancuso**. He was with the AEC-ERDA group. I forget at which time ERDA changed over from AEC, but he was the main contracting officer.

Mr. **Carter**. Is it correct that your former contract officer is now responsible for the Hanford data at Oak Ridge University?

Dr. **Mancuso**. At Battelle Northwest. Dr. Sidney Marks is located there. I do not know. You would have to ask him directly what his professional relationships are. I do know he is working very closely with Dr. Gilbert in the development of the statistical data which is analyzing our data and analyzing the Hanford data. So, I know he is deeply involved in that.

I also know he is concerned with it because in September of 1977, I had learned from Dr. Alice Stewart in a telephone conversation I had with her in England that Dr. Sidney Marks was circulating a document in this country relative to some adverse critiques of our particular project, and I made repeated requests to him relative to that, and that is documented in my testimony. I forget the exact dates, but roughly it is in September, and again on October the 5th and October the 13th, and then again in December. Then there was a statement by Dr. James Liverman, I think around November the 18th, or thereabouts—it is precisely indicated in my testimony—that in response to an interview at the Oak Ridge newspaper, the Oak Ridger, that he said that particular document would be available in a few days.

I sent a letter to Dr. Sidney Marks, asking him for that. In a letter of December 29th, he said that the statement of Dr. Liverman was premature, and that the document was not available as yet, and I have not received it as yet.

My particular concern relative to these documents was that we as scientific investigators like to learn about what particular critiques exist or are being generated. We feel that we are solid relative to our findings, and if anyone feels there is something negative about the data and not positive, there should be no reluctance to let us see it. But what happened, in effect, was that a number of the critiques of my final report were only obtained by chance through a Freedom of Information request in which we obtained about six critiques which I had never seen before.

I had seen some earlier critiques, but I had never seen those, and when Dr. Stewart arrived in the first week of January, I presented her with those, and she then proceeded to answer those critiques, and that is part of the testimony that has been submitted.

Mr. CARTER. Thank you.

Dr. Stewart, I understand that recent findings on the Japanese survivors of Hiroshima and Nagasaki show increased risk for those exposed to low levels of radiation. Is that correct?

Dr. STEWART. Yes, certainly. The recent findings have found an association between cancer at a lower level of dose than the earlier findings.

Mr. CARTER. There is a latent period before the development. Is that correct?

Dr. STEWART. Yes, presumably, for cancer.

Mr. CARTER. After the immediate sharp rise following the explosion you found, I believe, that this causes multiple myeloma. Is this also correct?

Dr. STEWART. Let me say that I have never had any direct—I mean, I only know what is published about the atom bomb survivors. I followed that, but in that population the first and most obvious effect of the X-rays was a disease known as myeloid leukemia, which is, of course, a disease that originates in the bone marrow. What we have found in the Hanford workers, is that—the number is exceptionally high for a closely related disease called myeloma, which also is in the bone marrow, and this is a current puzzle, why one population is one and the other the other.

Mr. CARTER. As I understand multiple myeloma, the X-ray films actually show an absence of bone in this area. The bone disappears. It is my feeling, Mr. Chairman, that one of the men who testified here may well have had that condition. What would you advise us here to do? Should there be an independent committee outside of ERDA and the military to evaluate the effect of low-level radiation on humans, or should there be an in-house committee to do this?

Dr. STEWART. Is this directed to me? Is it my opinion you want?

Mr. CARTER. Yes, ma'am.

Dr. STEWART. I think, speaking perhaps as an Englishwoman, that I should have thought the best thing to do would be to leave it to an independent university, and to see that the project officer came from one of your own government health agencies that is not directly concerned with the industry. That would seem to me not only for justice to be done, but for justice to seem to be done, which they always say is important.

Mr. CARTER. Mr. Chairman, I would like to compliment this lady as being one of the most intelligent, fluent, and articulate people who has ever testified before this committee.

Mr. ROGERS. You have advanced the cause, and we commend you.

I will ask some questions. As I understand it, your project director was Dr. Sidney Marks, at the time employed by the AEC.

Dr. MANCUSO. AEC.

Mr. ROGERS. So it was not a health agency employee who was your project officer, even though this is a study of health effects?

Dr. MANCUSO. AEC and ERDA were my contracting agency.

Mr. ROGERS. Yes; now, it is my understanding that in your testimony you said that Sidney Marks had requested that you issue a press release critical of Dr. Milham's findings in 1974.

Dr. MANCUSO. The interpretation of the wording of that is different. Let me put it in proper context.

Mr. ROGERS. OK.

Dr. MANCUSO. In the summer of 1974, at the time I had this major burst of telephone conversations at Hanford, and at the AEC headquarters, Dr. Sidney Marks had prolonged discussions, frequent discussions with me on the telephone relative to Dr. Sam Milham's findings, and also relative to my potential response to the press.

At the time, he dictated a press release to me which my secratary took over the telephone, and which was an AEC press release, and which said, in essence, and it is part of the testimony, that although the Milham findings were well appreciated, and so on and so forth, this was in contrast to the negative findings of the Mancuso studies, which were much more comprehensive, and so on and so forth.

Basically, the definite impression I got was, in effect, this is the essence of a press release and a position which I could take. I did not call any press conferences. I did not talk to the press relative to this, but this is only an indication of the tremendous concern by the AEC and ERDA at that particular time relative to the Milham findings.

Mr. ROGERS. Evidently, then, your contract officer, Sidney Marks, while at the AEC or ERDA, was instrumental in the decision to terminate your contract. Would he have been making recommendations at that level?

Dr. MANCUSO. Oh, yes. From information I obtained under the Freedom of Information Act, Dr. Sidney Marks was the author of the January 8, 1976 memorandum which represented a compilation of the in-house review. There were about four of the in-house individuals there, and the two outside reviewers are not named, and he would definitely be involved in the decision-making process.

Mr. ROGERS. Including a decision to terminate?

Dr. MANCUSO. Yes.

Mr. ROGERS. And who was his immediate superior?

Dr. MANCUSO. As far as I know, Dr. James Liverman.

Mr. ROGERS. It is my understanding that the study you were conducting has now been divided into two parts is that correct?

Dr. MANCUSO. Yes; one part relating to the Oak Ridge data has been assigned to the Oak Ridge Associated Universities. The other part has been assigned to Battelle Northwest to handle the Hanford population. At the time I developed and conceived the data, of course, we were in charge of all of this, and more relative to the AEC contracts.

Mr. ROGERS. So now part of it, the Hanford works, which had been in your study——

Dr. MANCUSO. That is right.

Mr. ROGERS [continuing]. Is now being done by Battelle?

Dr. MANCUSO. Battelle Northwest.

Mr. ROGERS. Which is a subsidiary component of Battelle, Inc.?

Dr. MANCUSO. I do not know the corporation thing, but it is the research arm there that is doing the research relative to radiation in that location. They are a subcontractor of AEC, ERDA, DOE now.

Mr. ROGERS. Who operates the Hanford works for DOE? Are you aware of that?

Dr. MANCUSO. No, I do not know the organization.

Mr. ROGERS. Is it Battelle, Inc.?

Dr. MANCUSO. The research is done by Battelle Northwest, but that is a part of Battelle, Inc.

Mr. ROGERS. That is correct. Now, it is my understanding that Mr. Sidney Marks is now employed by Battelle Northwest.

Dr. MANCUSO. Dr. Sidney Marks; yes.

Mr. ROGERS. So he was the one who terminated or helped in the decision to terminate, and he is now an employee of the company that is now doing part of the study that he asked you not to do. Is that correct?

Dr. MANCUSO. That is the way it appears.

Mr. ROGERS. We will get into that with the Department of Energy when they testify.

Now, let me ask you, were you ever provided a peer review criticism?

Dr. MANCUSO. No, sir. The only peer review that I obtained, a written peer review, was one I obtained by chance under the Freedom of Information Act. I never was given, nor saw them. The policy relative to the research contracts, was that you submitted a proposal, they would review it and carry out the proper procedures for funding, and then notify you usually a few months before the time was ready whether you had been approved or disapproved, but during all of these years, all of my projects had been approved, and there was never any question about it. All of the reports were approved.

Mr. ROGERS. Mr. Walgren?

Mr. WALGREN. As I understand the defense of ERDA and the funding sources, supposedly they made moves to transfer the study to the Oak Ridge in-house facility before the positive findings became available. Is that your understanding?

Dr. MANCUSO. They made a decision in the summer of 1974. Yes, sir, they made the decision to transfer the project to the Oak Ridge Associated Universities. At that time, as far as I can understand it, it was the whole project. I think subsequently they may have modified their relationship and come up by dividing it up as it now appears and as I have learned recently.

Mr. WALGREN. Was that subsequent to Dr. Milham's findings?

Dr. MANCUSO. That was at the same time period, and Dr. Milham's finding was the crux of the situation and was the trigger mechanism which led to the desire by the AEC-ERDA organization to control the data.

Mr. **Walgren**. Would you not think that the motive to pull the trigger mechanism was that when the context of Dr. Milham's findings became public, you would not totally cooperate with what was asked of you by ERDA in terms of denying the validity of those findings?

Dr. **Mancuso**. At the time we were discussing the Milham findings, I thought it was a most fortunate circumstance, because when you are a research professor, you go from one year to another with a contracting agency. You never know from one year to the other whether you are going to have a project or not, and yourself and your entire staff depends upon that. Naturally, you look for any hope for some basis to be able to convince the contracting agency that it is advisable to continue the study.

When Dr. Milham's findings occurred, this was a tremendous boost to the confirmation of the necessity of doing this particular study, and I think we ought to put certain things into perspective. When I began the study in 1964 and 1965, you know, and was going about to do this type of work, the AEC consultants had indicated it would be impossible to find anything unless the population was enlarged, and there was considerable concern as to whether I would find anything or not.

Nevertheless, I pursued this, but after the Milham findings of 1974, there was no question. It then became a sort of a remarkable vision by the AEC and ERDA, the foresight that they had to develop this project. Actually, historically, there are only about five people in the Division of Biology and Medicine and Operation Safety that I recollect who were strongly urging the promotion of this particular project, and it was their vision and their support which made it possible for me to continue this particular project.

Mr. **Walgren**. But before they talked of transferring the project to the Oak Ridge facility, they asked you to endorse certain comments and press releases about Dr. Milham's findings, and you refused to do so.

Dr. **Mancuso**. I think you would put it in this perspective. There were two reasons I expressed to Dr. Sidney Marks at the time he was talking to me about the Milham findings. I expressed two reasons why I thought that the Milham findings could be positive and ours negative at that time, and one Dr. Sam Milham has already referred to. That is, he had a larger number of deaths over a later period of time. It makes a tremendous amount of difference either in one or two years the number of deaths that you accumulate as to the analytical results you develop, at that particular point in time. I also mentioned the fact that the Atcheson-Jones population was also included in Dr. Milham's group, which was not in our group, and that group maintained the reactors. Those working we learned, had a higher level of radiation than most other workers.

Therefore, there were two good reasons why Milham's would be positive and ours negative at that particular point in time, but the inclination was, of course, that we would be advancing the negative findings as a means of counteracting Milham's proposal. But as I indicated to you before, this was really inappropriate, as events subsequently have shown. I only got the January 8, 1976 memorandum within a matter of months now. I did not see it before, but they were referring to the statistical quality of the data in those prior years before Dr. Stewart and George Kneale came onboard.

They did not hesitate at that point in time, and they did not say at that point in time that they were concerned about the statistical quality of the data, when they advanced the idea that they would use our negative findings as a means of counteracting Dr. Sam Milham's positive findings.

Mr. WALGREN. I understand that, and I simply want to put at a point in time your refusal to endorse press releases that the AEC drew up countering Dr. Milham's findings.

Dr. MANCUSO. I don't think you could put it, "refusal to endorse the press release." They advanced this. I did not accept it. I mean, they can say anything they want. If I don't do it, that is another story, and I did not do anything. You might term it in another context. Were you beginning to express a certain degree of independence? Yes.

Mr. WALGRAN. Now, that was before any of the positive findings were found, and also before any mention of transferring this project to Oak Ridge, Tenn.?

Dr. MANCUSO. To me, yes. I did not know at that time.

Mr. WALGREN. That expression of independence was your saying that the press reports or the press releases which they proposed to issue had not brought you to the firm conclusion they were advancing in those press reports or those draft press releases?

Dr. MANCUSO. I did not think there was any justification based upon our negative progress report to try to counteract Dr. Milham's, because our negative progress report was not in a position to do that. I mean, it is very difficult for me to remember everything that occurred during those times. There are certain things that have changed.

Mr. WALGREN. Thank you, Mr. Chairman.

Mr. ROGERS. Now, we got into one part of the contract that was given to Battelle, which is a contractor of DOE. Now, what about the Oak Ridge part? To whom has this been given?

Dr. MANCUSO. I guess you would call it the Oak Ridge Associated Universities. Yes, Oak Ridge Associated Universities in Oak Ridge, Tenn. I do not know their administrative setup and so forth, but I think there is a very close relationship between that organization and the atomic facilities at Oak Ridge.

Mr. ROGERS. Is that a DOE contractor?

Dr. MANCUSO. I do not really know.

Mr. ROGERS. We will go into that.

Let me ask you this. Is it your judgment that the Mancuso-Stewart-Kneale study results confirm the Milham study findings?

Dr. MANCUSO. Well, I would put it this way. Dr. Milham had come up with a positive association between prior Hanford atomic workers and excess cancer deaths. We then confirmed Dr. Milham's findings relative to an excess cancer among Hanford atomic workers in the work that Dr. Stewart and George Kneale did, and in addition were able to provide a dose-response relationship, that is, be able to relate it to the radiation exposure.

So, we went a step beyond Dr. Milham in the step that Dr. Milham had hoped the continued study would bring about, and we have come to that conclusion. There have been a number of critiques which we have received, which I mentioned to you, and which Dr. Stewart has responded to those which became available to us.

Mr. ROGERS. Let me ask you this. Are there any other studies with which you may be familiar which go into the health effects of low-level radiation?

Dr. MANCUSO. Well, the Smokey study, which is just getting underway now, would relate to low-level ionizing radiation, as I understand it. I think this is an extremely important study, but the limitations relative to the followup pertaining to the Smokey population is that we do not have each individual person badged, and we do not have this information.

Mr. ROGERS. Are you familiar with the study done by Dr. Bross?

Dr. MANCUSO. Yes. I am familiar with his work. I think Dr. Bross would be the best person to talk about that particular project. He has done a tremendous amount of work realtive to low-level ionizing radiation.

Mr. ROGERS. I note that in the newspaper, the Oak Ridger, of Oak Ridge, Tenn., of November 18, 1977, there was a specific quote by Dr. J. Liverman in response to a question about the Mancuso findings that, "He had requested an independent study, the results of which are expected in a few days."

Did you take any action when you found that out?

Dr. MANCUSO. I wrote a letter to Dr. Sidney Marks and asked him for that. Is is the same report, as I understand it, which has been around for many months, and as I indicated before, he had written back on December 29 saying, in effect, that that statement was premature, that Dr. Liverman was not in a position, evidently, to know, and other developments had occurred, so that it would be delayed before it could be made available.

Mr. ROGERS. I understand you had two workers, a Sanders and a Brodsky.

Dr. MANCUSO. That is right.

Mr. ROGERS. One of them, I believe, was critical of your work, but I am not sure of the details. Could you just tell us briefly about that situation and why they left your project? Are they competent scientists and statisticians?

Dr. MANCUSO. That is right. Dr. Alan Brodsky was a health physicist, and a very good health physicist. He was formerly with the University of Pittsburgh when I was there. He was very helpful in the development of the study in its early years, and he left purely for his own personal professional reasons. It had nothing to do with any relationship on our project. I think he left our project with considerable reluctance. He was very much interested in the project, but he was making a change at the University of Pittsburgh in his professional status, and he was doing other work relative to teaching and also relative to consultant work.

So, basically, the number of years that Dr. Brodsky was with us was a much shorter period of time, and the fact that he left bore no relationship to our finding in any way.

Dr. Sanders is an actuarial expert who began with me on the project in early years, who was extremely helpful, and I have commended him highly for the remarkable work that he developed relative to developing the data and organizing the data. The differences of opinion between Dr. Sanders and I occurred in the last few years of our project, in which Dr. Sanders felt very strongly and definitely that the findings were negative, and was pressing me very hard to publish the negative findings, and I insisted that this should not be so, and he went over my head and circulated certain documents relative to that.

Be that as it may, I had brought in Dr. Stewart and George Kneale in May of 1976, and during the summer of 1976, as you will find in the attachment, July 27, 1976—there is an attachment, the letter addressed by Mr. George Kneale to Dr. Sanders [see p. 569], in which George Kneale provides, an analysis which says, in effect, that the interpretation of the analysis Dr. Sanders was conducting was inappropriate, that if you had a certain amount of radiation it would reduce the risks of dying by 42 percent.

This, of course, confirmed by strong reservations relative to the inappropriateness of publishing a negative finding, and this led to a break between myself and Dr. Sanders. At the same time, I was able to elicit the support, get the professional help, fortunately, of Dr. Stewart and George Kneale. They continued the analysis and identified that in fact the data was not negative but was positive, that there were positive findings, and then they proceeded to identify certain reasons why, as Dr. Stewart indicated earlier, why there were certain relationships between the radiation dose between the dead and the alive which was misleading to my former actuarial consultant.

Mr. Rogers. As I understand it, then, you had no difficulty with the AEC as long as you had negative findings. But, as soon as you had a positive finding, your contract was terminated and has been given to other people.

Dr. Mancuso. I feel that it is a matter of record. It would be just a remarkable coincidence if one wants to term it as a coincidence, that in all the years in which the project reports were negative, the most elaborate, cordial relationships existed. They did not threaten me in any way. They did not consider discontinuing the project in any way. Everything was moving along just fine. In the summer of 1974, things seemed to change, and I think they sensed at that time that maybe the project, with continued analysis, we would also find positive results like Dr. Sam Milham had, and sure enough, we did, but I think they were anticipating their needs for the future years, and made plans accordingly. I was not privy to what plans they had, and I cannot say. I can think and believe what motivated them, but I could not positively say what they actually said during those meetings.

Mr. Rogers. Did they ever have your studies reviewed as long as the results were negative?

Dr. Mancuso. That is a very good point. I was thinking about that the other day, and you know, that is a remarkable thing. All through the years when we had these negative findings, they had never convened an independent panel to say, Dr. Mancuso, we don't think that your findings are really negative, we are going to convene an expert panel to find out why they are negative.

They never did that, but they tried to do that when they became positive. It is equally important when it is negative, particularly if you are coming up with a false negative project. Negative makes it doubly important that we not mislead society, or mislead the scientific community.

Mr. **Rogers.** If your findings are justified, would it perhaps necessitate a review of the radition safety standards now required throughout the nuclear industry?

Dr. **Mancuso.** Yes, Mr. Chairman, I do believe so. I do believe that this experience leads us to the observation that there is a marked increase relative to the risk of getting radiation-induced cancer far greater than anyone had noticed before, and that the limits relative to standards should be lowered, and steps should be initiated to bring together a convening of the scientific groups to exchange views relative to this, to see what could be done relative to moving downward the standards on radiation.

Mr. **Rogers.** Fron your experience, do you think you can get an unbiased report from an in-house study?

Dr. **Mancuso.** I am sorry to say no. I severely resent the idea that all during these years that I was conducting this project as an independent investigator—I have been approached because of my so-called pioneering effort in industrial epidemiology—that while the progress report was negative, it was perfectly all right to have this project at the University of Pittsburgh, and I as an independent investigator. What changed my independent status? Under what basis was I no longer the independent scientist who was able to conduct, conceive this project, and carry it out for so many years?

It happened in the summer of 1974. There was no indication prior to that time, and I see absolutely no reason on the basis of whatever they have advanced, publicly, privately, or in the press, to substantiate different findings.

I want to remind you again that it was in the summer of 1974 that Dr. Liverman, in response to a letter specifically addressed to him by Secretary Schlesinger, in his reply to Dr. K. Z. Morgan, that he said, in the summer of 1974, because of Dr. Mancuso's imminent retirement. He did not state in that letter and he did not include in that letter anything about adverse peer review, and he did not give as a justification poor performance.

It would seem to me that if that was the reason, then it would have been appropriate for him to have included that.

Mr. **Rogers.** Thank you for your presence today.

Dr. **Mancuso.** I have one other point I would like to make if you will permit me.

Mr. **Rogers.** Certainly, and I will say, if it is possible, we hope you will be present during the hearings, because we might want to call you back.

Dr. **Mancuso.** I would like to make one point, and I have to say it more or less in my own defense, because one of the arguments that were used by ERDA in the January 8, 1976 memorandum and in previous conversations with them was my reluctance to publish, and I have given the reason why I have refused to publish, but I would like to bring to the committee's attention a letter which I obtained under the Freedom of Information, again by chance, which shows a remarkable inconsistency relative to the ERDA position.

ERDA has criticized the lack of publication of the scientific reports, as in the memorandum of January 8, 1976, and accepted this as the main reason for termination of the contract, yet ERDA as of September 29, 1977, and I underline the year, 1977, September 1977, acknowledged that "it would have been extremely difficult to conduct meaningful analyses at an earlier time period."

A letter from Dr. Walter Weyzen, manager of Human Health Studies Program, Division of Biomedical Research, to Ms. Pat Borchman of California, dated March 29, 1977, states on page 2, the last paragraph—and I have underlined that, and I have attached that letter to the testimony—

> Most cancers have latency periods of up to several decades. Consequently, it would have neem extremely difficult to conduct a meaningful analysis at an earlier time period.

This is now a public acknowledgment by ERDA that prior analysis and publication of such analyses would not have been meaningful. This an acknowledgment that prior analysis and publication during the years in which the AEC and ERDA repeatedly urged me to publish the then negative findings of the progress reports would have been misleading to the public and to the scientific community, as I stated in the introduction to the final report in 1977.

This public acknowledgment by ERDA that prior analysis and publication of such analysis would not have been meaningful contradicts ERDA's own statements cited in a meeting memo of January 8, 1976, as reasons for deficiency of performance.

Some questions therefore could be raised as to why the ERDA staff has cited and accepted the poor publication reason as a reason for the termination of the research project.

Mr. ROGERS. Thank you very much, Dr. Mancuso.

It is now 12:35. The committee will adjourn until 2 p.m., at which time we will hear from the Department of Energy. Thank you for your presence and help to the committee. The subcommittee stands adjourned until 2 p.m.

[Whereupon, at 12:35 p.m., the subcommittee was recessed, to reconvene at 2 p.m. of the same day.]

AFTER RECESS

[The subcommittee reconvened at 2 p.m., Hon. Paul G. Rogers, presiding.]

Mr. ROGERS. Dr. Liverman, if you would like to introduce your colleagues, your statement will be made a part of the record, and you may proceed as you like.

STATEMENTS OF JAMES L. LIVERMAN, PH. D., ACTING ASSISTANT SECRETARY FOR ENVIRONMENT, DEPARTMENT OF ENERGY; ETHEL S. GILBERT, PH. D., BIOSTATISTICS, PACIFIC NORTHWEST LABORATORY; AND GEORGE B. HUTCHISON, M.D., M. PH., PROFESSOR OF EPIDEMIOLOGY, HARVARD SCHOOL OF PUBLIC HEALTH, ACCOMPANIED BY JOSEPH SELTZER, ACTING INSPECTOR GENERAL, DOE; WALTER WEYZEN, M.D., PH. D., DIVISION OF BIOLOGICAL ENVIRONMENTAL RESEARCH, MANAGER, HUMAN HEALTH STUDIES PROGRAM, NEVADA OPERATIONS OFFICE, DOE; SEYMOUR JABLON, PROGRAM DIRECTOR, NATIONAL ACADEMY OF SCIENCES; AND SIDNEY MARKS, M.D., PH. D., BIOSTATISTICS, BATTELLE CORPORATION

Dr. LIVERMAN. Thank you, Mr. Chairman. It is a pleasure to be before the subcommittee. I am sorry I missed the first meeting.

I would like to start by introducing my colleagues: Mr. Seymour Jablon, of the National Academy of Sciences, who is the program manager for the program in Japan which is following the survivors of the atomic bombings there. He would be prepared to discuss that in detail, if you wish.

On my left is Dr. Gilbert, whom we have heard about this morning. On my immediate right is Dr. Walter Weyzen, who is the manager of the Human Health Studies Program in the Department of Energy. On his right is Dr. George Hutchison, of the Harvard School of Public Health. On the far right is Mr. Joe Seltzer, from the Office of the Inspector General of the Department of Energy. I would like to proceed with my statement, if I may.

Mr. ROGERS. Certainly.

Dr. LIVERMAN. In accordance with your letter of February 1, we delivered to the subcommittee staff this morning the total records of the Mancuso contract from 1973 onward. It constitutes about 2 boxes, something like 15 volumes of material. As you know, the contract started in 1964. The additional material from 1964 through 1972 will be made available to the subcommittee as it may wish.

Mr. ROGERS. Thank you. The committee appreciates it.

Dr. LIVERMAN. I would like to say that I joined the Atomic Energy Commission in November of 1972, which became ERDA and then the Department of Energy October of 1977. Thus, much of the period of the contract had transpired before I joined the agency; nevertheless, it is clear to you that I am the individual responsible for the ultimate decision to transfer the Mancuso program.

The subject of these hearings, as you so eloquently pointed out this morning, is to address the biological effects of very low levels of radiation; more specifically, the adequacy of present radiation protection guidelines. We have had much discussion about that this morning. A comprehensive review of all currently available information on the effects and a careful evaluation of the risks of ionizing radiation is contained in a recent report which I believe the subcommittee is aware of, entitled "Sources and Effect of Ionizing Radiation," which was put out by the United Nations Scientific Committee on the Effects of Atomic Radiation. It includes a considerable amount of new information which has become available to that body since 1972, when they issued their last report.

I am pleased to say that much of that information was generated by studies supported by the Atomic Energy Commission and its successors. It is also important to state at this time that the 1977 reevaluation of all available information on the effects of ionizing radiation has not indicated a need for any significant reduction in the guidelines for the protection of the general public or workers in the nuclear industry.

Much was said during the January 23 and 24 hearings before this subcommittee concerning risks to individuals exposed to low levels of ionizing radiation. I believe it is pertinent in the context of this hearing to address briefly one of the considerations that is basic in evaluating the risks of low level radiation.

The evaluation of the risk of cancer or any other somatic effect from ionizing radiation requires knowledge of the dose-effect relationship. Current knowledge of the dose-effect relationship of low-level radiation is incomplete and risk evaluation must be based on the extrapolation of data on the effect of higher doses of radiation on animals and man.

Such an analysis must take into account the nature of the association between exposure to radiation and the effect observed, interpreted in the light of existing knowledge. Clearly, then, the study of radiation-induced cancer in human populations exposed to low levels of radiation, or for that matter any other environmental insult, is extremely complex. Large populations must be studied to obtain an accurate incidence of cancer. Few populations exist that are large enough to provide quantitative dose-effect data.

Other complications relate to the long latency which we have talked about this morning between insult and the appearance of clinical evidence of damage. In fact, long latency complicates the completeness of the followup of these populations. One of the current Department of Energy-supported studies on the effect of low-level radiation, in which this subcommittee has expressed a special interest, is the Study of the Lifetime Health and Mortality Experience of Employees of AEC Contractors, now renamed the Health and Mortality Study.

Responsibility for this study which was initiated in 1964 under the principal investigator, Dr. Mancuso, was transferred to the Oak Ridge Associated Universities in 1977. Let me outline the rationale for the study, the scope of the project as conceived, its development over the years, and the basis for my decision to transfer the responsibility for the study elsewhere. Upon completion of the testimony, and with permission of the subcommittee—and it is certainly, totally your decision—there are other individuals here who are prepared to discuss this in detail. Dr. Gilbert has done a thorough analysis of the mortality of the Hanofrd workers, which you have heard about this morning. Dr. Hutchison will discuss the findings by Dr. Mancuso and coworkers in the light of existing accepted knowledge.

As stated earlier, the principal information available in radiation exposures in humans stems from the study of atomic bomb survivors in Japan and other studies which pertain to acute exposures. The effects of chronic low-level intermittent exposures, which might be experienced by certain employees in the nuclear energy industry, were predicted to be minimal and probably nondemonstrable, but were never really documented.

Thus, from time to time, the question has been raised and one which this subcommittee again is raising, as to the safety of the workers in the nuclear industry, particularly: the health and mortality experience of workers in this field. While there have been undocumented studies of employee groups within the industry, in which no detrimental effects could be detected, it seemed desirable to develop a more careful evaluation and documentation of the health and mortality of a significant number of workers over the past 30 years.

Historically, a study of this general nature was recommended by the Atomic Energy Commission's Advisory Committee for Biology and Medicine in 1963, and then recommended by the Directors of the Divisions of Biology and Medicine and Operational Safety to the General Manager of the AEC in 1963. It was then taken to the Commission itself for approval.

It was to be a four-part feasibility study that would (a) consider whether existing professional techniques to study health experiences could be readily and effectively used in a system common to all AEC contractors; (b) consider whether or not this system could be devised to bring together and correlate radiation measurement data and health events data such that it might demonstrate adverse health effects, if any, over a long period of radiation exposure; (c) evaluate further methods and procedures of uniformity, completeness, accuracy, dependability, and measurability that could be devised to allow the meaningful identification of health events during individual's employment in the industry; as well as to consider whether this process could be instituted at a reasonable cost; and (d) whether pertinent health events occurring between the termination of employment and the time of death could be identified and correlated with sufficient accuracy and frequency to permit the drawing of any meaningful conclusions.

In response to a request, the Commission approved the study, and Dr. Mancuso, with whom discussions had begun, recommended a 1-year study to determine the scope and dimensions of the investigation and whether a longer term study would be worthwhile. His initial study, I believe he would agree, addressed the questions concerning the long-term biological effects on populations exposed to specific environmental stresses, in this case, obviously, radiation being the major concern. The questions raised were:

What kinds of industrial health, environmental exposure, insurance, and other related data were required to provide a sound basis upon which to answer those questions?

What was the quality and quantity of such data currently available at selected installations? Finally, could more meaningful epidemiological procedures be designed by supplementing existing data?

A study was initiated on June 1, 1964. As Dr. Mancuso has said, the result of that first year's study was to establish a 5-year project, a pilot program, in selected contractor atomic energy installations, to establish the feasibility of carrying out an epidemiological investigation correlating lifetime health and mortality data with occupational radiation exposure.

The facilities selected initially were at the Hanford plant, Washington, and at Oak Ridge, Tenn. An additional objective was to identify the problems, and there were many, I am sure, and to determine the feasibility of extending the study to all AEC contractor facilities.

The program was divided into three general phases:

One: Organizing and arranging for work to be done by other facilities and agencies, that is, other than Hanford and Oak Ridge—planning the statistical design, data abstracting, and conversion to magnetic tape.

Two: Data processing, programing, tracing deaths of identified workers, and obtaining death certificates; and

Three: Coding deaths, data processing, analysis, presenting results, and phasing from retrospective into prospective protocols.

In March 1969, the principal investigator and his colleagues presented their conclusion that the feasibility of conducting a meaningful epidemiological study had been established in terms of success in obtaining a reasonably accurate determination of the mortality and exposure status of a vast majority of employees and suitable persons to use as controls, that is, persons with no known occupational exposures.

Expansion of the project to other AEC facilities, as recommended by Dr. Mancuso, was not approved because of relative budget priorities and the need to focus this project on the selected facilities in the initial phases of the study. The title of the project was changed from "Feasibility Study of the Correlation of Lifetime Health and Mortality Experience of AEC and AEC Contractor Employees With Occupational Radiation Exposure" to "A Study of the Lifetime Health and Mortality Experience of Employees at AEC Contractors."

In June 1969, Dr. Mancuso proposed that he use not only longevity as a measure of low-level radiation effects in humans, but also extend the study to include other physiological phenomena, temporary, or long-lasting disability or any nonspecific cause that reduces the working life of an employee. This was not approved for the reasons indicated above, mainly because of budget priorities and the need to focus the project on mortality.

Beginning in fiscal year 1972, the employee population under study was expanded to include the Mound Laboratory.

In December 1974, the staff of the Division of Biomedical and Environmental Research recommended to me that the study be moved to the Medical and Health Sciences Division of the Oak Ridge Associated Universities. The reason for recommending such a move to a new institution was based on the negative outcome of a technical evaluation of the study and not because of Dr. Mancuso's "imminent retirement." Much has been made in the press and elsewhere of my use of the phrase "imminent retirement" to refer to the status of Dr. Mancuso's employment. It is clear to me as a result of having reviewed the facts in detail that my use of the words "imminent retirement" was unfortunate, inappropriate, and perhaps, even in error.

It is equally clear, however, from the record that the question of retirement was brought up by my staff a number of times. In particular, the December 2, 1974, memorandum recommending transfer of the program specifically stated that, "Dr. Mancuso would be 65 years old in 1977 and that termination of the program at his university in 1977 prior to transfer should not cause him personal hardships." In fact, it was felt that Dr. Mancuso would wish to stay on as a consultant to the program, but we felt he should not remain as the principal investigator.

While I must accept the responsibility for the unfortunate use of the above words, this fact should not cloud the much more critically important set of conditions which led to the decision to transfer the program. Some of these were:

A clear lack of substantive publications appearing in reference journals. Even papers on Dr. Mancuso's methodology for analysis would have been highly useful.

A reluctance on Dr. Mancuso's part to initiate any analyses until all data collection was complete, a clear difficulty in studies requiring massive data bases which take a long time to compile. The reason given was that the results might be misleading; however, generally, in studies like this, it is crucial that trends, positive or negative, get identified early so as to guide studies more directly as one proceeds. Related to this point is the accusation, voiced by some, of suppression of data. As far as I, personally, am aware, no results of any project supported by the Division of Biomedical and Environmental Research have been suppressed by personnel or management of BER programs.

A judgment by his scientific peers that the work should be limited, terminated, or another investigator selected to be the principal investigator.

The need from the agency's standpoint is to insure that the records constituting this study could be preserved for posterity and be readied for transfer to new program management.

Thus, in summary, while my use of the phrase "imminent retirement" was unfortunate and perhaps overstated, other factors were overriding in importance if effective management and timely progress on such an obviously important program were to be achieved. It seemed important that the records be preserved for more vigorous study, not only by Dr. Mancuso, but also by the body of scientists equally competent to carry out investigations.

It is the scientific validation of presumed facts that must form the cornerstone of the regulations used to insure safety. The competent scientific views of many are to be preferred over those of a few. The actions taken on this matter were aimed to insure just such scientific validation not only for now, but for those who may wish to examine the records in the future.

In March 1975, Dr. Mancuso was informed at a meeting at the Energy Research and Development Administration headquarters that his contract would be extended through July 31, 1977, and that it would be terminated on that date.

By memo of July 9, 1976, Dr. Mancuso informed the members of his advisory committee and DOE that, "Dr. Alice Stewart and George Kneale began an independent analysis of our study data on May 27, 1976."

In October 1976, Dr. Mancuso and coworkers presented the results of their analysis of the Hanford data, conducted during that year, to my staff. Thus, it was not until some 19 months after Dr.

Mancuso was notified of the ultimate termination of his contract that we received definite results of his analysis of the Hanford data.

The results presented indicated an increased incidence of various cancers at radiation exposure levels that were significantly below those at which effects had been observed in other studies, such as those of the survivors of the atomic bombs in Japan.

My staff urged Dr. Mancuso at that time to subject these findings to a peer review group. About that time, I requested that a group of four experts, in the fields of radiation epidemiology and biostatistics, review the study of the Hanford workers. Also, when Dr. Mancuso's final report of this study became available, I again requested expert opinion. One of the four experts who participated in these reviews is Dr. Hutchinson, Harvard University, School of Public Health, who is present today to answer any technical questions that your subcommittee may have.

During the past several years, scientists at the Pacific Northwest Laboratories have also been involved in analyzing the Hanford data. The principal investigator, Dr. Ethel Gilbert, of the Battelle Pacific Northwest Laboratories, is here today and is prepared to discuss her findings on the Hanford workers. This study has been carried out independently of Dr. Mancuso.

In summary, I would like to state that the possibility of certain somatic effects of low levels of irradiation cannot be excluded. On the other hand, aside from cytologic and cytogenetic abnormalities, the pathological significance of which is unknown, no radiation injuries have been established in man under exposure conditions compatible with current radiation protection guidelines. While currently accepted radiation protection guidelines cannot be shown to provide absolute safety, I believe, based on current knowledge, that they do provide adequate assurance for the protection of workers and the general public.

I am sure that the members of this subcommittee are aware that, recently, serious allegations have been raised with regard to DOE's management of the contract with the University of Pittsburgh. When such a letter implying improper management was received by the Secretary, it was sent to me for response. I immediately drafted a memorandum to the Inspector General in which I said, "This is one I cannot touch. You, sir, should do this." The Inspector General, as you are aware from the legislation creating the Department of Energy, is a totally independent office within the agency. He reports only to the Secretary and to the Congress, and is responsible to no one else, and I felt that I could do nothing less than to subject the total files available in my organization to whatever examination was felt necessary to clarify the charges.

That completes my prepared testimony, Mr. Chairman. I will be glad to respond to any questions you have, or if you prefer, the other members of the panel can present their material, and we will proceed as you may wish.

Mr. ROGERS. I think we could hear from the other witnesses and then have questions.

Dr. LIVERMAN. Mr. Chairman, whom would you like to hear from?

Mr. ROGERS. Whomever you decide.

Dr. LIVERMAN. Dr. Gilbert?

STATEMENT OF ETHEL S. GILBERT, PH. D.

Dr. GILBERT. I initially became involved in this study as a result of Dr. Milham's positive findings. Because these were in conflict with the conclusions of reports of Mancuso and Sanders, we were asked to reevaluate the data. This effort gradually expanded from the initial proportional mortality analysis—this was referred to by Dr. Milham—to a more definitive population-based analysis. There are advantages, I think, to conducting this analysis at Battelle, since we have ready access to persons who are knowledgeable about the exposure and occupational data.

In my testimony today, I will be reporting on the results of this latter population-based analysis, and, to keep this reasonably brief, I will be omitting many details which are included in my written testimony [see p. 643]. I would be glad to elaborate on any specific points in which you are interested. I would also be glad to comment on the discrepancies between the results and conclusions of my study and those of others who have analyzed these data.

The Hanford mortality study was originally designed as a population-based study; that is, data files have been maintained on all Hanford workers, including survivors, in order that mortality data can be related to the population at risk. Since this approach is generally considered to provide more reliable results than an analysis in which only deaths are considered, as is the case in both the Mancuso-Stewart analysis and also in the Milham analysis, we felt that we should utilize the data on survivors. We have analyzed this data in two different ways. First, to provide a certain perspective, we have compared the death rates of Hanford workers with those of the U.S. population. Second, we have tried to relate the death rates of Hanford workers to the radiation exposure they have received.

In carrying out the first type of analysis, we calculate quantities called standardized mortality ratios, or SMR's, as they are sometimes called. An SMR is the number of deaths observed in the population of interest expressed as a percentage of the number of deaths that one would expect if U.S. rates prevailed, taking age and calendar year into account.

Some of these SMR's for major causes are presented in table 2 of my written testimony. The group of greater interest are the longer term Hanford workers, that is, those who have worked there for more than 2 years. This group will include most of the workers who have the higher exposures. The number of deaths observed from all causes is just 75 percent of what one would expect, based on U.S. statistics. Probably this should be increased by 5 percent or so to allow for deaths that have been missed by the Social Security Administration.

This low SMR is actually pretty typical of a population employed in a clean industry. Factors such as pre-employment screening, medical surveillance programs, health insurance, and, simply, the more favorable standard of living that goes with being employed tend to result in lower death rates for employed persons than those for the general population. These factors tend to affect noncancer causes more than they affect a disease such as cancer.

For this reason, if you are only looking at deaths and looking at them proportionately, that is, the proportion of deaths due to a particular cause or causes, cancer can appear high. The SMR for cancer in this population is higher than for certain noncancer causes. Cancers are about 85 percent of what one would expect, but it is still well below the normal 100; again, this is quite typical of an employed population.

We also calculated standardized mortality ratios for a number of specific cancers which are included in table 3. There is quite a range in these SMR's, mostly due to random variation. There are no specific cancers which are significantly higher than 100. It is, I think, particularly interesting that leukemia and lung cancer are both significantly under 100. These are cancers that have been associated with radiation exposure. I will turn now to our exposure analysis, which is probably more meaningful as far as determining the effect of radiation per se.

The goal of this analysis was to compare death rates for those workers with the highest radiation exposures to a group as comparable as possible with respect to everything but radiation exposure. For this reason, we restricted this analysis first to workers who had been employed for at least 2 years, and also to workers whose employment period extended beyond 1960. This group includes nearly all of the higher exposures.

We did not use U.S. data at all in this analysis. We did calculate observed and expected deaths, but this time the expected deaths are the number of deaths that would be expected if radiation had no effect in this population. The results of this analysis are presented in table 4.

The interpretation of these results is that, looking at the two highest categories, if radiation is having an effect, one will find that the observed deaths exceed the expected deaths. If radiation is having no effect, the observed and expected deaths should be nearly equal.

We controlled this analysis for such factors as age, occupation, and calendar year. Dr. Stewart is quite right that factors such as age could be different for different exposure groups, so it is very important that an analysis be controlled for some of these factors, and we did do this.

There are two specific cancers which do exhibit a significant positive correlation with radiation exposure. These are multiple myeloma and cancer of the pancreas. These inferences, however, are based on quite a small number of deaths. Certainly, the hypothesis that some of these deaths have been caused by radiation exposure has to be given very serious consideration. However, I do not think that we can rule out completely the possibility that pre-Hanford exposures or other factors in the Hanford environment might also play a role in these deaths.

For the remaining specific cancers, the observed deaths never exceed the expected by more than a fraction of a death. Examining cancer in totality, there are 26 deaths observed compared with slightly less than 30 expected in the higher exposure group. Thus the overall death rate in cancer from those with higher exposures is no greater than for a comparable group of workers with lower exposures.

For all causes of death, death rates are slightly lower for those with a higher exposure, although this difference is not significant.

In conclusion, I would like to note that this is an ongoing study, and I will second the comment that Dr. Milham made that I think it is extremely important that we continually reevaluate the evidence as additional mortality data become available to us.

[Testimony resumes on p. 656.]

[Dr. Gilbert's prepared statement follows:]

TESTIMONY BY

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The Hanford plant, which is located in southeastern Washington, was established in the early forties as an installation for plutonium production. Many of the workers employed by the various contractors hold jobs involving some exposure to radiation. Yearly records of this exposure, obtained from dosimeter readings, as well as occupational data, are maintained for all employees. Mortality data are obtained by having the Social Security Administration periodically search their records for deaths of persons identified in the personnel rosters of Hanford contractors.

For the past two and a half years, I have been involved in the analysis of the Hanford data. In this presentation I will concentrate on discussing the major results of this analysis. Since our conclusions differ from those of others who have analyzed this data (Mancuso, Stewart and Kneale [6], and Milham [10]), I will try to indicate some of the ways in which our methods and results differ from theirs.

METHOD OF ANALYSIS

A major difference in our approach at Battelle is that we have done a population-based analysis rather than a retrospective or proportional analysis. In a population analysis, one identifies a group of individuals and follows them for a prolonged period of time to observe when they die and the extent to which they die of specific diseases. In the retrospective approach, one considers only the deaths (without relating them to the population at risk) and examines the relative numbers dying of cancer or other causes of interest.

The example given in Table 1 illustrates the two approaches and also demonstrates a potential difficulty in interpreting proportional analysis. In this example, we assume that there are 1000 persons at risk in Group 1 and 200 at risk in Group 2. (For simplicity we assume that the groups are similar with respect to age and other important variables.) Using these denominators, it is clear that the two groups have identical cancer death rates, but that the death rate from causes other than cancer is higher in Group 1 than in Group 2. However, in a proportional analysis, these denominators are not used. Rather, the proportions of deaths due to cancer are examined and compared for the two groups. Since, in Group 1, 100 of 400 deaths, or 25%, are due to cancer, while in Group 2, 20 of 60 deaths, or 33-1/3% are due to cancer, we could be led to the conclusion that Group 2 has excess cancer when in fact the cancer rates are identical in the two groups.

TABLE 1. Example illustrating possibility of false impressions created by a retrospective or proportional analysis as opposed to a population based analysis.

	Group 1	Group 2
Number at Risk	1000	200
Cancer Death Rate	$\frac{100}{1000} = .10$	$\frac{20}{200} = .10$
Noncancer Death Rate	$\frac{300}{1000} = .30$	$\frac{40}{200} = .20$
Proportion of Deaths Due to Cancer	$\frac{100}{400} = .25$	$\frac{20}{60} = .33$

This is one of the difficulties in both the Milham and the Mancuso, Stewart and Kneale (MSK) analyses. In the Milham analysis, it is not higher Hanford cancer death rates but lower noncancer death rates than the corresponding rates for the general population of Washington State that result in a higher proportion of cancer deaths. In the MSK analysis, as we shall see, Hanford workers with lower or no exposures have higher death rates from various noncancer causes than do more highly exposed workers, causing cancer to appear proportionally excessive for the latter group in their analysis. Although results are not generally expressed as proportions in the MSK analysis, this bias affects many of their results since deaths in their analysis are not related to the population at risk.

COMPARISON WITH U.S. MORTALITY

The Hanford data has been analyzed in two ways. The analysis that I will emphasize in this presentation is one in which death rates are related to exposure status. However, to provide perspective on the magnitude of the death rates, the rates for Hanford workers are also compared with those of the U.S. population. To carry out this comparison, we calculate standardized mortality ratios (SMRs), which indicate in percentage form the ratio of deaths observed in the population under consideration to the deaths expected in the same population if U.S. rates prevail (100 x observed deaths ÷ expected deaths). Expected deaths are calculated in a way that takes the age and calendar year distribution of the population of interest into account.

The interpretation of absolute SMRs is conditioned by a selective bias known as the "healthy worker effect." Typically, employed populations exhibit low SMRs [9] since persons considered poor health risks are screened out during preemployment examinations. In the case of Hanford workers, health may also have been favorably affected by the availability of excellent health insurance and medical surveillance programs long before they became widespread in the industry. Some deaths may also be missed by the Social Security Administration. (One estimate of the percentage of deaths missed in this manner is 6% [12]. For these reasons, low SMRs are not interpreted to signify protective effects of exposure factors. On the other hand, low SMRs are not compatible with important adverse effects, and, taken at face value, mean that those employed groups may have prospered from a health standpoint under their conditions of employment.

It is important to note also that the healthy worker effect is typically of lesser magnitude for cancer than for most other causes of death [4, 9]. The factors responsible for the healthy worker effect do not have the same impact on cancer as on many other diseases. This differential effect becomes especially important in interpreting proportional mortality analyses. In an analysis such as Milham has carried out, a reduction in mortality from causes other than cancer inevitably increases the proportion of cancer deaths.

In Table 2, SMRs are presented for a few major cause of death categories. Only white males employed prior to 1965 are included in the analysis with workers employed less than two years considered separately from longer term workers.

The number of observed deaths occurring in Hanford white males employed at least two years is 75% of what would be expected based on age-calendar year specific rates for U.S. white males. The SMR for malignant neoplasms for this group is 85%. Both these results are quite compatible with the "healthy worker effect" discussed earlier. For the short term workers the all-cause SMR is 86%, higher than for the longer term workers. This difference is due to deaths from noncancer causes since the cancer SMRs are similar for short and long term workers. Since nearly all the higher exposures are found in the longer term Hanford workers, the deficiency of deaths from noncancers for this group will cause cancer to appear elevated among those with higher exposures in a proportional analysis such as that undertaken by Mancuso, Stewart, and Kneale.

In Table 3, SMRs for several specific cancer types are presented. The wide range of SMRs is at least partially due to random fluctuation. None of these SMRs are significantly greater than 100, and only cancer of the lung and leukemia are significantly less than 100 ($p < .05$). It is particularly interesting that the SMR for leukemia is so low since this is the cancer that has been most strongly associated with radiation exposure in other studies [2,3,13].

The above analysis provides no evidence of excess mortality from cancer or any other cause in the Hanford population. However, to adequately investigate the role of radiation exposure, the relationship between mortality and exposure data must be examined at greater length.

RADIATION EXPOSURE DATA

Figure 1 shows the distribution of doses accumulated through 1973 for 12,678 white males employed at Hanford at least two years. The distribution is highly skewed, reflecting the fact that the predominant exposure for most Hanford employees is natural background radiation (typically about .1 rem per year) while a relatively small number receive occupational exposure on a regular basis (in the range of 1 to 4 rem per year). With data as skewed as this, means and t-tests are generally considered to be inappropriate since, unless sample sizes are very large, one or two large doses can greatly inflate the mean and exaggerate significance levels obtained from the t-statistic. One difficulty with the MSK analysis is that it uses the mean and t test frequently with sample sizes that are unduly small for the radiation dose distribution.

TABLE 2. Observed deaths, expected deaths and Standardized Mortality Ratios (SMRs) for major causes of death in white males grouped by length of employment.

	Length of Employment					
	<2 Years			2+ Years		
Population at Risk	7,767			13,075		
Number with 5+ Rem Cumulative Dose	2			2,778		
Cause of Death	Obs.	Exp.[a]	SMR	Obs.	Exp.	SMR
All Causes	1905	2216.6	86	2089	2796.8	75
All Malignant Neoplasms (140-209)[b]	319	363.0	88	414	487.7	85
Diseases of the Circulatory System (390-429, 440-458)	839	965.4	87	955	1254.2	76
Accidents, Poisonings and Violence (800-999)	243	222.9	109	216	288.8	75
All Other Causes	423	568.1	74	455	700.8	65
No Death Certificate[c]	81			49		

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[a] Expected deaths are calculated from age-calendar year specific U.S. mortality rates for white males, 1945-1967.

[b] International Classification of Diseases (ICD) codes.

[c] Expected deaths and SMRs are corrected for those deaths with no certificates on the assumption that the distribution of causes is similar for those with and without certificates.

TABLE 3. Observed deaths, expected deaths and Standardized Mortality Ratios (SMRs) for specific cancer types in white males grouped by length of employment.

	Length of Employment					
	<2 Years			2+ Years		
	Obs.	Exp.[a]	SMR	Obs.	Exp.	SMR
All Malignant Neoplasms (M.N.) (140-209)[b]	319	363.0	88	414	487.7	85
M.N. of Buccal Cavity and Pharynx (140-149)	6	12.6	48	18	17.0	106
M.N. of Esophagus (150)	8	8.7	92	11	11.9	93
M.N. of Stomach (151)	17	27.8	61	23	33.3	69
M.N. of Large Intestine (153)	23	33.5	69	44	43.6	101
M.N. of Rectum (154)	6	15.0	40	13	19.0	68
M.N. of Liver (155, 156)	12	10.7	112	7	13.6	51
M.N. of Pancreas (157)	27	20.7	130	28	28.1	100
M.N. of Larynx (161)	5	8.8	57	5	7.9	63
M.N. of Lung (162)	93	101.5	92	115	147.7	78
M.N. of Prostate (185)	24	24.0	100	25	27.8	90
M.N. of Kidney (189.0)	9	9.0	100	13	12.5	104
M.N. of Bladder (188, 189.1-189.9)	5	11.9	42	10	14.9	67
M.N. of Skin (172, 173)	5	6.7	75	8	9.5	84
M.N. of Brain (191, 192)	11	11.5	96	17	16.7	102
M.N. of Thyroid (193)	(2)[c]	(0.8)	250	(0)	(1.3)	0
M.N. of Bone (170)	(0)	(2.5)	0	(2)	(3.1)	65
Leukemia (204-207)	9	16.1	56	10	21.6	46
M.N. of Other Lymphatic and Hematopoietic Tissue (200-203, 208, 209)	18	22.2	81	33	31.5	105
Other M.N. (Residual)	51	44.3	115	47	60.0	78

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[a] Expected deaths are calculated from age-calendar year-specific mortality rates for U.S. white males, 1945-1967. For cancer of the lung, leukemia and M.N. of other lymphatic and hematopoietic tissue, U.S. data for 1945-1973 are used.

[b] ICD codes.

[c] Observed or expected death values less than 5 are enclosed in brackets.

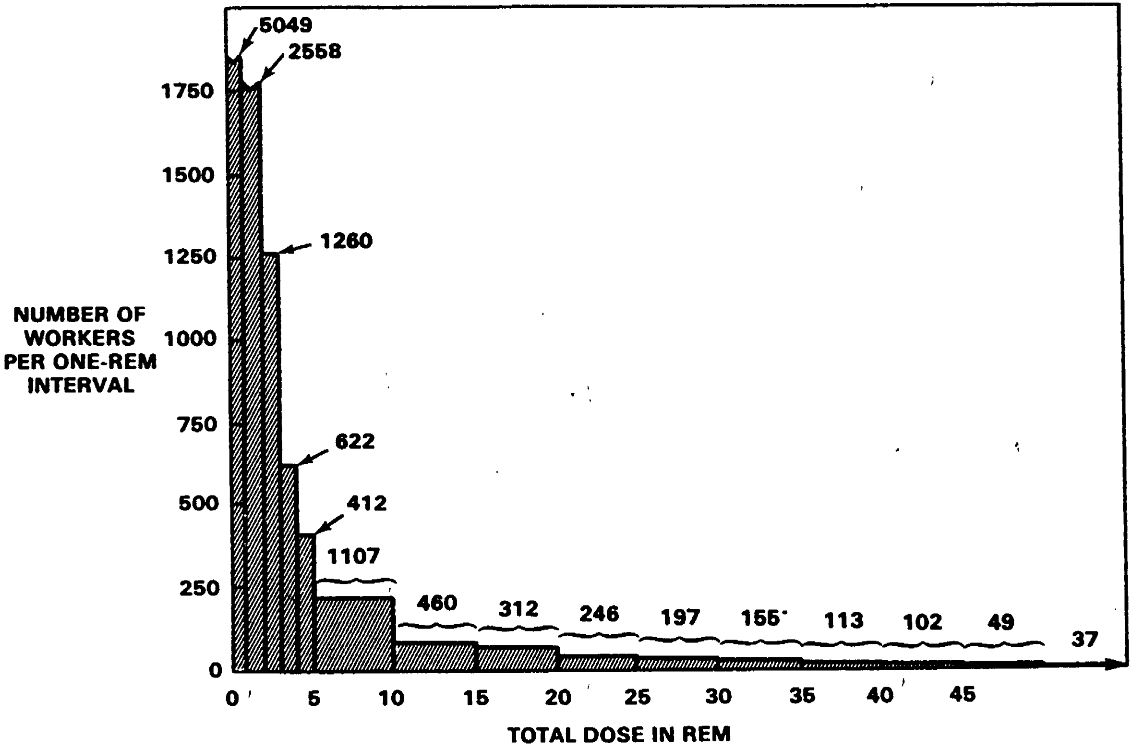

FIG. 1. DISTRIBUTION OF CUMULATIVE DOSES FOR WHITE MALE WORKERS EMPLOYED AT LEAST TWO YEARS

Radiation exposure is correlated with a number of variables that may also affect mortality. None of these are adequately accounted for in the analysis of Mancuso et al. Calendar year, in particular, is very highly correlated with exposure--partly because few doses of much magnitude (over 1 rem) were received in the early days at Hanford, and partly because it takes a number of years to accumulate a substantial dose. This is especially important with respect to lung cancer since U.S. rates from this cause have nearly doubled between 1950 and 1970 [11]. Most of the higher exposures were received by workers in a few specific occupations, all classified as craftsmen or operators. These workers may have smoking habits* and occupational exposures (other than radiation) which differ from the remainder of the Hanford population. Since it has been demonstrated that occupation and its associated socioeconomic status can affect mortality [12], it is important to consider this factor in our analysis. Finally, length of employment is related to both exposure and mortality patterns as discussed in the previous section.

EXPOSURE ANALYSIS

An objective in this analysis is to compare workers with higher exposures to other workers who are as similar as possible in every respect except for their level of radiation exposure. For this reason, the exposure analysis is limited to 7729 white males who were employed at Hanford at least two years and whose employment period extends beyond January 1, 1960. Of the 2778 men with total doses exceeding 5 rem, only 77 (2.8%) fail to meet these criteria while just 3 (.2%) of the 1211 men with total doses exceeding 15 rem are excluded from this group.

The basic method of analysis is to categorize all active workers at a given time and then compare the subsequent mortality experience of the various exposure groups. Only past exposure for a stated time is included since future exposure would be correlated with survival--that is, the longer one survives the more opportunity one has to accumulate exposure. Exposures are categorized in 1960 and again in 1965. A more extensive description of the method has been presented previously [5].

The four exposure groups selected are workers having total doses less than 2 rem, 2-5 rem, 5-15 rem, and 15 or more rem. The Mantel-Haenszel method [7] is used to calculate expected deaths. That is, the combined experience of all four groups is used to calculate the number of deaths expected in each dose group if mortality rates are not affected by radiation exposure. Rates for the U.S. population are not used here. The calculation of expected deaths is done in a way that adjusts for age (in

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Data are not available on the smoking habits of Hanford workers.

5-year intervals), for occupation (by separating craftsmen and operators from the remaining occupations), and for calendar year (by separating experience between 1960 and 1964 from experience from 1965 to 1974).

RESULTS AND DISCUSSION OF EXPOSURE ANALYSIS

In Table 4, the observed and expected deaths for the four exposure categories are presented for all causes of death, all cancer, and several specific cancer categories. The interpretation of these results is as follows: If radiation is positively correlated with mortality, the observed deaths in the higher exposure categories will exceed the expected. If there is no correlation, the observed and expected deaths will be approximately equal.

The cause of death which has been most strongly associated with radiation exposure by other studies [2,3,13] is leukemia. With a single death observed in the 5-15 rem group and a half a death expected in the highest two exposure groups, we cannot conclude that there is an association between radiation exposure and leukemia in the Hanford population.

There are only two specific cancer types for which the observed deaths in the two highest exposure groups exceed the expected by more than a fraction of a death. They are multiple myeloma and cancer of the pancreas. A one-tailed exact permutation test for trend [7] yields a p-value of .01 for multiple myeloma and .03 for cancer of the pancreas. In interpreting these results, it is important to keep in mind that, when several statistical tests are performed, false positive results are not unusual. Moreover, the results for the two cancer types are based on a very small number of deaths (3 cases of multiple myeloma and 4 of cancer of the pancreas in the highest exposure groups). The possible role of exposure to other occupational agents such as chemicals, either during or prior to Hanford employment must also be considered. It is important to examine these causes of death particularly closely as additional mortality data become available. However, we do not feel that we have sufficient evidence to conclude that a causal relationship exists, especially since these diseases (multiple myeloma and cancer of the pancreas) are not as clearly associated with radiation exposure as leukemia, for example.

When we investigated whether an excessive number of deaths due to all cancers as a group were observed at the higher exposure levels, we found no evidence of an increase. In the highest two exposure groups 26 cancer deaths are observed compared with 29.8 expected. Thus the small number of excess deaths from multiple myeloma and cancer of the pancreas are compensated for by a deficiency of deaths from certain other cancer types (prostate, other digestive organs, for example). When deaths from all causes are examined, there are fewer deaths observed than expected in the highest two exposure groups.

TABLE 4. Observed and expected deaths due to selected causes by exposure category for white males included in exposure study (see text).

Cause of Death	Exposure Category								Probability of Trend Arising Due to Chance[b]
	0-2 rem		2-5 rem		5-15 rem		15+ rem		
	Obs.	Exp.[a]	Obs.	Exp.[a]	Obs.	Exp.[a]	Obs.	Exp.[a]	
All Causes	587	578.5	122	113.1	84	96.3	44	49.1	>.5
All Malignant Neoplasms (M.N.)	112	117.9	33	23.3	15	19.5	11	10.3	>.5
M.N. of Buccal Cavity	4	3.3	0	.7	1	.6	0	.4	>.5
M.N. of Colon	11	12.5	4	1.8	0	1.2	1	.5	>.5
M.N. of Pancreas	7	8.8	3	2.2	1	2.0	3	1.0	.03
M.N. of Other Digestive Organs	11	10.9	3	1.9	1	1.6	0	.7	>.5
M.N. of Lung	34	39.1	14	8.2	7	7.0	3	3.8	>.5
M.N. of Prostate	10	7.4	1	1.5	0	1.3	0	.9	>.5
M.N. of Brain	4	6.3	3	1.2	1	.9	1	.7	.18
Lymphosarcoma and Reticulum Cell Sarcoma	2	1.5	0	.5	1	.6	0	.4	>.5
Hodgkins Disease	2	2.1	1	.5	0	.4	0	.0	>.5
Leukemia	3	2.9	0	.6	1	.3	0	.2	>.5
Multiple Myeloma	1	2.3	0	.6	1	.8	2	.4	.01
Other Neoplasms of Lymphatic and Hematopoietic Tissue	2	1.6	0	.3	0	.1	0	.0	>.5
All Other Cancers	21	19.3	4	3.4	1	2.8	1	1.4	>.5
All Noncancer Causes	461	449.2	89	87.3	66	74.9	33	37.6	
No Death Certificate	14	11.4	0	2.5	3	1.9	0	1.2	

[a] Expected deaths are calculated from the experience of all workers in the exposure study, allowing for age, occupation, and follow-up stratum.

[b] The significance levels are for a one-tailed test.

As an additional means of summarizing these data, we express the results for various exposure groups in terms of deaths per thousand per year. These rates, which are presented in Table 5, are adjusted for age, occupation and calendar year with all Hanford workers included in the exposure study considered the standard population[1]. To keep these estimates reasonably precise, these rates are calculated only for all causes of death and all cancer. Attention is restricted to experience between ages 25 and 70, and the 5-15 rem and 15+ rem exposure groups are pooled. There is no evidence of a consistent increase in death rates with exposure status. In fact, death rates are lowest in the 5+ rem exposure group. However, differences in the observed rates are well within what we would expect from random variation. U.S. rates are included for comparison.

COMMENTS ON THE MANCUSO, STEWART, KNEALE ANALYSIS

Since the conclusion of Mancuso, Stewart and Kneale that there is a causal relationship between radiation exposure and several cancer types is not supported by our analysis, it seems appropriate to summarize briefly a few of our difficulties with the MSK approach. In the retrospective approach used by MSK, exposure levels for deaths due to all cancer, as well as various specific cancer types, are compared with exposure levels for deaths from causes other than cancer. The problem with this approach is that an apparent excess of deaths due to cancer may in fact represent a deficiency of deaths from noncancer causes. This is the case in the MSK analysis of the Hanford data. Since longer term Hanford workers (with nearly all of the higher exposures) have lower death rates from noncancer causes than do the shorter term, predominantly exposed workers (see Table 2), the proportion of cancer deaths appears to be excessive among those with higher exposures. The authors do not even consider this interpretation of their results.

Control for age of death and calendar year of death are a standard part of any reliable mortality analysis. Although age of death is considered for all cancers (see MSK Table 11), it is not considered for any specific cancer. Calendar year of death is given no consideration. Length of employment and occupation are other variables which are not controlled; yet, these variables are highly correlated with radiation exposure.

The MSK analysis relies heavily on the mean and t-test with data that is extraordinarily skewed and sample sizes that are frequently very small. (Note that in MSK Tables 12-15, the sample sizes for predeath years greater than zero are often much smaller than the number of deaths given at the bottom of the table.) Means, t-tests and doubling doses can be greatly influenced by one or two large values. The doubling dose is also very dependent on their choice of the linear model.

TABLE 5. Age-, calendar year-, and occupation-adjusted mortality rates by exposure category for white males aged 25 to 70 included in exposure study (see text); rates per 1000 person-years (approximate 95% confidence limits are given in parentheses)

	Exposure Category			U.S. white males
	0-2 rem	2-5 rem	5+ rem	
All Causes	7.8 (±.9)	7.5 (±1.4)	6.7 (±1.3)	11.0
All Malignant Neoplasms	1.7 (±.4)	2.1 (±.8)	1.4 (±.6)	2.1

SUMMARY OF RESULTS AND CONCLUSIONS

Mortality from all causes for white males employed at Hanford for at least two years is 75% of that expected on the basis of U.S. vital statistics. Mortality from cancer is 85% of the expected. These results are typical of a working population. Neither death from all causes nor death from all cancer types shows a positive correlation with external radiation exposure. In fact, death rates from all causes are slightly lower for Hanford workers with higher exposures than for those with lower exposures. It is particularly noteworthy that leukemia, the disease that several studies have found to be associated most strongly with radiation exposure, is not correlated with external radiation exposure of Hanford workers. Two specific cancers, multiple myeloma and, to a lesser extent, carcinoma of the pancreas, are found to be positively correlated with radiation exposure. While these associations warrant attention, one must consider the possibility that they may be due to random variation or to other factors in the Hanford environment.

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Dr. LIVERMAN. Mr. Chairman, Dr. Hutchison can summarize his statement in about 10 to 15 minutes, if you would like to hear that.

Mr. ROGERS. That would be fine.

STATEMENT OF GEORGE B. HUTCHISON, M.D., M. PH.

Dr. HUTCHISON. My name is George Hutchison. I am professor of epidemiology of the Harvard University School of Public health. I have been engaged in research on the effects of radiation in human beings for approximately 15 years. I am presently a consultant to the Department of Energy and a member of a group of four outside consultants asked by the Department to review the report by Mancuso, Stewart, and Kneale, which has been presented this morning by those workers.

Our group of four consultants has reviewed this paper, and one of us has obtained the computer tape and done some further analyses of these same data. I will speak about the published paper and our further analyses. My comments are necessarily my own statement and opinion, but they do reflect analyses done by the other three of our group.

Our group of four consultants has exchanged written comments among ourselves, but we have not completed our review, and have no statement reflecting our joint position at this time.

First, I would comment on the preliminary nature of the data. The published report is described by the authors, Drs. Mancuso and Stewart and Kneale, as preliminary findings, and I would like to emphasize that. Specifically, this is a report based entirely on deaths among the Hanford workers, and does not include information on the total population at risk. This is a common and well accepted method of analysis for epidemiologists as preliminary investigation. It does not, however, take advantage of all of the information, and it is subject to a variety of interpretations. Certain conclusions can be made from this sort of preliminary analysis, but a final understanding can come only when the analysis of the total data is complete.

The analysis is preliminary in another way. The authors have considered the fact of several incidental variables and the main variables which are the radiation exposure and the cancer. These incidental variables are some that have been mentioned by Dr. Gilbert just now: the calendar year of death, the number of years in the occupations involving exposure, and the time between exposure and death. Each of these variables is examined separately in Dr. Mancuso, et al.'s paper, but in a final analysis beyond the preliminary analysis one would want to consider the possible joint influence of several or all of these incidental variables.

In a supplement Drs. Stewart and Kneale have sent us, such joint analysis has indeed been done, but this has not been done for the individual cancer sites in which these authors have reported the striking radiation hazard.

Our further analysis is also preliminary. It again involves only the deaths. We, too, have not looked at the total exposed population. We have controlled simultaneously for age of death and year of death, and in so doing the important finding of a striking association of lung cancer with low-level radiation disappears from the conclusions.

We understand the authors do indeed intend to do further analyses along these lines, both to include the total population and to do further adjustments by multiple variables, and we, too, hope to study the data further.

A comment about the statistical significance test. The tests that have been used in Dr. Mancuso et al.'s paper result, we believe, in an erroneously large estimate of the significance of their findings. This was pointed out early in their analyses, and they have noted the problem in an appendix, but they have taken this into account only with respect to the two cancers which they and we find to be increased by low-level radiation.

In our analysis, we find only two cancers significantly increased, the two that Dr. Gilbert has mentioned, multiple myeloma and cancer of the pancreas. Furthermore, with the corrected significance test value, we believe the demonstrated excess risk may be either in both of these two sites, multiple myeloma and pancreas, or in either one alone. We do agree with the published report that certainly at least one cancer and possibly both multiple myeloma and cancer of the pancreas must be significantly increased in this population, and this finding must be considered a very important result of their study.

On the question of the doubling dose, the authors have used an interesting analytic procedure to estimate the doubling dose for cancer mortality. The estimate of doubling dose is highly unstable, statistically, and we believe it should not be taken as an important finding of the study, that is the actual magnitude of this doubling dose. We believe a doubling dose can logically be determined only for the two cancers where we feel an increase in incidence has been found, in multiple myeloma and cancer of the pancreas. For both of these two sites, the excess cases occur only at radiation doses of 25 rad or greater. There are no excess cases at cumulative lifetime exposures below 25 rad.

This dose of 25 rad is lower by a factor of four than the dose we have previously supposed was the doubling dose for these cancers, but it is not an order of magnitude lower, as the authors suggest. Again, we accept the major finding of the authors, but we believe it is quantitatively less than they have estimated.

A point about the efficiency of the analytic methods used. The authors have used a method of analysis that is not the most familiar to epidemiologists, althogh it is not an unknown method. Dr. Stewart and Mr. Kneale have noted the comments by several reviewers about the use of this method, and they have recently submitted to us a statement showing the relative efficiency of the several methods.

In this study of relative efficiency, they have suggested the available population is not large enough for the method of analysis that we have used, referred to as the SMR or the standard mortality ratio, which has been discussed today several times. The number of persons required, according to the appended analysis of Mr. Kneale for the SMR procedure, is given as 135,000 persons, which is more than the number of persons in the whole Hanford population.

This figure, however, must be interpreted not as persons but as the number of person-years, each person having been observed for some length of time. When this is taken into account, the number of person-years is entirely adequate for the SMR procedure that we had used alternatively to the CMD, comparative mean dose procedure that Mr. Kneale has used.

If the SMR analysis, the standard mortality ratio which we have used, were confined simply to a comparison of two exposure groups, exposed and not exposed persons, then it would certainly be true that the method used by Stewart and Kneale would be more efficient, statistically, than our method. Our analysis, however, is not a simple comparison of an exposed and a not exposed group. It is a comparison of a variety of dose levels up to 10 dose levels, and we believe that the efficiency of this procedure would be very similar to the efficiency of the CMD procedure as used by Stewart and Kneale.

Finally, in closing, I want to comment on the implication of the new data. Do they imply a substantial departure from old ideas of radiation hazard? First, I would comment in clarification about the old ideas. Most of us have long held, as has been expressed this morning, that there is, in fact, no safe dose of radiation exposure. We have seen a clear demonstration of hazard in the range of 100 rad, and we believe that all smaller doses, however small, do indeed carry some hazard, not seen in most studies simply because they require such enormous populations to be studied.

We interpret the permissible population exposures and occupational exposures not as harmless levels, but as levels carrying small hazard commensurate with benefit. It is our interpretation that the number of excess cancers found in this study is approximately four cases over the expectation. This number may be as high as eight. It may be smaller. It may be only one or two. These are about 4 or 8 or 1 or 2 extra deaths among 3,520 deaths and 24,949 employed people. We are not happy to have four extra deaths. We are not happy to have any extra deaths in people exposed to ionizing radiation, but we do feel this is, conceivably, in the range commonly considered commensurate with the benefit of use of ionizing radiation.

The findings, however, are not consistent in other respects with our conventional beliefs. We do not commonly find these two sites, multiple myeloma and cancer of the pancreas, increased in populations in which leukemia is not found to be increased. Leukemia is the most readily and clearly demonstrated excess cancer in most large studies of external exposure. Multiple myeloma and cancers of the pancreas are both known to be produced by ionizing radiation from other evidence but not previously as the most prominent or only results.

Further, we do not commonly find such an effect in adults at doses in the range of 25 to 30 rad as found here. Several explanations come to mind. The first, and most important, is that other studies are wrong in their estimate of the size of the risk, wrong, perhaps, by a factor of approximately four. If so, more stringent permissible dose levels must be set. Another possible explanation is that the other studies concern principally higher doses given in one exposure or a small number of exposure fractions. The present study, as has been discussed during the day here, involves low doses given in extreme fractionation. This fractionation may be peculiarly hazardous relative to these two cancer sites, the multiple myeloma and pancreas, while the present concepts are correct for higher doses at lesser fractionation.

If this is true, one must consider whether the hazard of increasing the risk relatively of two very uncommon cancer sites actually imposes a greater overall health benefit than the long accepted smaller hazard to many sites at these low doses.

The peculiar site distribution of multiple myeloma and pancreas may, as still a third explanation, imply that the effect is not due to the reported radiation doses at all.

The first explanation that has been considered is that it is due to internal emitters rather than to the external radiation for which we have the film badge readings. We do not believe that this alternative explanation is correct. There may, however, be other industrial agents to which this population is exposed, and which may be highly correlated with the use of ionizing radiation, and these could, alternatively, be explanations.

Thank you.

Mr. ROGERS. Thank you very much.

Dr. LIVERMAN. Since Dr. Bond could not be here, may I simply introduce his statement into the record?

Mr. ROGERS. Without objection.

Dr. LIVERMAN. Since we got it in a draft form——

Mr. ROGERS. Do you have copies of it?

Dr. LIVERMAN. It came in the mail, when it looked like he might not make it, and he may want to make a few corrections.

Mr. ROGERS. I think Dr. Carter would like to see it, and then it will be put in the record.

Mr. CARTER. I would like to see it, and then it can be placed in the record.

Dr. LIVERMAN. We thought it might be useful.

Mr. ROGERS. Thank you.

[Testimony resumes on p. 666.]

[Dr. Bond's statement referred to follows:]

STATEMENT BY

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ON

RADIATION EFFECTS IN MAN

BEFORE THE
HOUSE COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE
SUBCOMMITTEE ON HEALTH AND ENVIRONMENT

FEBRUARY 8, 1978

Mr. Chairman and members of the Committee:

I am pleased to be here today to testify on behalf of the Department of Energy. The Hearings today are on the biological effects of low level radiation, and the adequacy of present radiation protection guidelines. I should like first to summarize briefly the history and present status of the radiation guides, and then summarize biological effects data relevant to those guides.

Unitl about the mid-19~~5~~40's, radiation protection guides were based conceptually on the idea of a "threshold dose", i.e., there is a dose (or dose rate) above which a definite hazard from exposure exists, and below which there is a complete absence of hazard. The threshold dose, then, represented a clear delineation between a "safe" level of exposure, and "unsafe" levels. In the ~~mid~~ early-1950's, this philosophy was changed substantially, and the "no threshold" concept was introduced as the basic philosophy for radiation standards (1). This change was brought about, not because of any demonstrated effect of radiation at doses and dose rates commensurate with the standards then ~~extent~~ existing, but because of the "trend of scientific opinion". This trend was based on then-recent extensive dose-effect data for genetic effects in ~~mice,~~ Drosophila, indicating the lack of a threshold.

This change in philosophy represented a major step in toxicology, introduced by and pioneered in radiation protection, but now applied to many other hazardous agents to which man is exposed. With this type of approach, it follows that any amount of exposure carries with it, not a certainty, but a probability, however small, that some effects might result particularly in a sufficiently ~~some member(s) of a~~ large population so exposed ~~may develop an effect~~. With the introduction of this concept, the words "safe" and "unsafe" disappeared from the lexicon, and was replaced with statements of the probability that a given exposure might result in harm. Also, since the important and relevant effects (e.g., genetic effects and carcinogenesis) occur normally in unexposed populations, it became impossible to assign definitely cause and effect relationships between the injurious agent and a presumed effect. With most industrial or other hazards, the cause of an effect is easily identified (e.g., the cause of a broken arm is usually established easily). With radiation (and many chemicals), however, it is impossible to establish cause and effect, other than on a probability basis. As an example, it is not possible to determine whether a given case of leukemia is of "natural" origin, or may have resulted from a previous, even large radiation exposure. Only probabilities can be estimated.

The real radiation guide then became, to quote from the 1958 NCRP Handbook 59 Addendum (1), "Radiation exposures from whatever sources should be as low as practical". This philosophy has been stated in various ways, e.g., "All exposure should be as low as practicable, and no exposure should be allowed without some expected compensating benefit". Radiation guides, such as the basic 5 rem/yr, were established as guides, or administrative upper limit exposure levels, not to be exceeded in routine operations. It would be expected that the average dose would be considerably less than that. It was ~~would~~ also be expected that the probability of harm would be so low, that no effects would be detectable even in a large population. Thus it is clearly stated that occupational radiation exposure is potentially hazardous to the individual.

The question of "over exposure" i.e. (the total exposure for a given period of time has exceeded the guide), the statement is made that "transient deviations from the

ICRP # 26 clearly states, and I quote, that "the dose equivalent limits should not be regarded as a dividing line between safety and danger; when limits have been exceeded by a small amount it is generally more significant that there has been a failure of control prescribed levels are unimportant" (1). The principle is stated more directly in one of the BEAR reports (2), as follows: "If certain figures (such as 10 roentgens) occur in a recommendation, it should most emphatically not be assumed that any exposure less than that figure is, so to speak, "all right", nor should it be for a moment assumed that disaster will suddenly descend if one of these figures is exceeded."

From ICRP 26 (3), the following is quoted: "Deleterious effects cannot be unequivocally associated with exposures within the dose equivalent limits, and medical surveillance has no part in confirming the effectiveness of a radiation protection program." ~~This means that~~ clearly, then exposures somewhat above the guides constitute no basis for medical surveillance.

Standards rest on scientific data reported in the world literature. For instance, the change to the no threshold concept was based on the reported observation that, "The frequency of the effecT curve increases linearly with the dose with gene mutations and is independent of a duration of exposure" (1), and the philosophy has not changed (the statement on dose rate independence has since been shown to be incorrect, and the effect is actually lower with lower dose rate). A great deal of experimental data on biological systems and in man is accumulated throughout the world, and much of this type of investigative work in the United States has been supported by the AEC-ERDA-DOE. These data have been examined, collated and analyzed over the years by a large number of national and international groups. Examples are the following:

1) Non-governmental groups such as the NCRP in the United States, and the ICRP representing many nations. Analyses of data are issued periodically, and recommendations are made with respect to exposure limits.

2) A Rockefeller-Institute supported extensive study of the somatic and genetic effects of radiation was undertaken by NAS/NRC in 1956 (2). This review was updated in 1960, and a similar very extensive study was undertaken by the "BEIR Committee"

of the NAS/NRC, in 1972 (4). A followup study by the Academy is underway currently, and a report is expected in the near future.

The International Scientific Community has provided input through the UNSCEAR reports, a series that started in 1958 and continues to the present. The last extensive report was published in 1977 (5). In each of these studies, all relevant data known to the Committee members was assessed and evaluated. Thus current authoritative overall assessments of radiation risks are continuously available, and radiation exposure standards are continuously reassessed on the basis of such current analyses.

Each reviewing group has concluded that "linear extrapolation" from intermediate dose levels leads to an upper limit of risk at low doses and dose rates, and it is often stated that the actual risk may be substantially lower. It is relevant to note the conclusions of the latest international scientific body, published in the 1977 UNSCEAR report, on the carcinogenic effects of low level radiation. The Committee came to the conclusion that the overall risk of fatal malignancy of all kinds, resulting from exposure of the whole body to low-LET (x- or gamma) radiation is about $100/10^6$rad, or about $5/10^6$/yr/rad if a "plateau" of 20 years is assumed. This value does not differ significantly from that derived by the earlier BEIR Committee (6).

The 1977 report also addresses further the question of "linearity", i.e., is the risk/rad the same at low doses as it is at high doses. It is stated that the risk coefficients given above are strictly speaking for doses in the range of 100 rad or above. With respect to lower doses the statement is made, "while the rate per rad from doses of a few rad is unlikely to be higher than this value, it might be substantially lower". In other words, the summary judgment of the group, after reviewing available data, is that "linearity" in general is most likely conservative. This would support the conclusion that "linearity", historically assumed to be a reasonable assumption on which to base radiation protection philosophy and guies, remains a reasonable assumption.

With respect to needed research, clearly additional investigative work on animals and on human populations exposed to radiation is needed. Epidemiological studies on human beings should have a high priority. Basic research on the mechanisms of radiobiological action definitely should not be neglected, however, since the ultimate answers with respect to effects of radiation in biological systems will never be completely satisfactory until the underlying mechanisms are well understood. This will come only from basic studies in radiation biology.

With respect to the adequacy of present radiation standards, I agree with Dr. Karl Morgan who testified before this Committee last week. He stated, I believe, that he was satisfied with the basic radiation guides, provided that the "low as practicable" basic tenet of the Radiation Protection Guides is adhered to. I would find it difficult to improve on the basic philosophy, that "exposure should be as low as practicable, and no exposure should be allowed without compensating benefits". The basic radiation protection guide of 5 rem per year remains satisfactory in my opinion. Substandards within that overall guide may need adjustment, and they have been adjusted when circumstances warranted this.

As an example, the exposure ~~guide for~~ design guidance for the population around operating ~~central~~ station nuclear power generating facilities has recently been reduced (made more restrictive) by a factor of a level has recently been set at a level more restrictive than the basic population guide of 500 mrem about 100. This ~~change was introduced,~~ not because any effects had been demonstrated, but simply because it had been shown by experience that exposure to the public from such plants could be kept to lower levels. It has been debated whether or not the costs of additional effluent controls mandated the ~~change~~ represented a correct assessment of cost-benefit; nonetheless the change does indicate that the "low as practicable" philosophy with respect to exposure is receiving attention.

REFERENCES

1) National Council on Radiation Protection and Measurements. Permissible Dose from External Source of Ionizing Radiation, NCRP Handbook 59, 1954. See also the Addenda to Handbook 59, one issued in 1957 and a second in 1958.

2) National Academy of Sciences/National Research Council. The Biological Effects of Atomic Radition (The BEAR Committee) NAS/NRC 1956.

3) ICRP Publication 26, Recommendations of the International Commission on Radiological Protection. Pergamon Press, January 17, 1977.

4) National Academy of Sciences/National Research Council. The Effects on Populations of Exposure to Low Levels of Ionizing Radiation. The "BEIR" Committee Report, NAS/NRC, 1972.

5) The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). Sources and Effects of Ionizing Radiation, UNSCEAR, 1977.

6) The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). Ionizing Radiation: Levels and Effects, United Nations, 1972.

Dr. LIVERMAN. That is all, sir, unless the Inspector General wants to comment.

Dr. SELTZER. I have no comments.

Mr. ROGERS. I think we will get to him in the questioning. Mr. Carter, would you like to start?

Mr. CARTER. Thank you, Mr. Chairman.

Dr. Hutchison, you are a consultant to this group. Is that correct?

Dr. HUTCHISON. Yes, sir.

Mr. CARTER. Do you consider ionizing radiation a cause of cancer?

Dr. HUTCHISON. Yes, I do, sir.

Mr. CARTER. Of what kind, particularly?

Dr. HUTCHISON. My belief is that it probably is capable of causing almost every kind, sir, in humans at an appropriate dose. I would make one exception to that, namely, chronic lymphatic leukemia, which I believe has never been demonstrated to be increased in association with radiation exposures in any human populations.

Mr. CARTER. Of course, there are many types of leukemia. Are they easy to differentiate?

Dr. HUTCHISON. There is certainly confusion in differentiating the types of leukemia.

Mr. CARTER. Yes, I have found that and I know it to be true. Can you really tell the difference between histiocytic and lymphocytic leukemia?

Dr. HUTCHISON. I myself cannot tell the difference among any of them, sir. If you are asking whether a hemotologist whose skill this is—Is this your question? Do hemotologists have a difficulty in differentiating?

Mr. CARTER. Whom do you consider the foremost authority on leukemia in the United States?

Dr. HUTCHISON. I do know the answer to that question. Dr. William Moloney in Boston was heavily involved in the leukemias in the early ABCC studies.

Mr. CARTER. In my view, Dr. Emil Freireich in Boston, Dr. Emil Frei, at M. D. Anderson, and Dr. Jim Holland at Mount Sinai, seem to know more in this area and are more able in their treatment of different leukemias than most. Yet, even for them, the differentiation of different kinds of leukemia is extremely difficult.

You mentioned a Dr. Moloney, who didn't even know that hairy cell leukemia had been known for 20 years. He stated it had only been known for eight or ten years. He further stated there is no association between it and radiation, even when there have been no studies made to support that contention. He also said there was no way of telling the leukemias that developed at Hiroshima and Nagasaki as to whether they were hairy cell or what type. We did not have an electron microscope at that time so that we could tell?

Is that not true?

Dr. HUTCHISON. I do not know what the date of introduction of the electron miroscope is. I believe that is correct.

Mr. CARTER. I believe that is correct. So, in making these statements, it seems to me, there is a great interest to protect the status quo. What is a safe level of radiation?

Dr. HUTCHISON. As I indicated in my prepared statement, I do not use the term "safe" level myself. My feeling is that there is no safe level.

Mr. CARTER. There is no safe level. Thank you, sir. That is a very good statement.

You spoke of a 25-rad dose. What is a rad, Doctor?

Dr. HUTCHISON. A rad is a measure of the concentration of energy in tissue derived from radiation. A physicist would have to state the specific definition of this.

Mr. CARTER. Rad stands for radiation absorption dose. Is that not correct?

Dr. HUTCHISON. That is correct, sir.

Mr. CARTER. What is rem?

Dr. HUTCHISON. A rem is the measure of the rad multiplied by the relative biologic efficiency. It is a concept used to compare various sorts of radiation.

Mr. CARTER. So rem is not really a measure of absorption but rad is. They are both actually referred to as a roentgen. Rad is absorbed dose. Is that not correct?

Dr. HUTCHISON. I believe both the rad and the rem should be referred to as an absorbed dose. Roentgen is exposure, not absorbed dose, but the rem is related to the rad in that it is a conversion from the absorbed rad dose to something else of equivalent effect.

Mr. CARTER. It is the radiation absorbed by a man exposed to one roentgen of radiation. I believe that is the definition of it.

What do you use as a level in the film badges beyond which you will not go? When you let workers into the Hanford works, for instance, what level do you consider safe? How many rems or rads per day do you consider safe? You should know this, I would think.

Dr. LIVERMAN. How many rem per day?

Mr. CARTER. Yes, or what fraction of a rem?

Dr. **Liverman**. We try to keep the exposures as absolutely low as possible, and we do not tolerate any exposure if we can prevent it.

I am not a health physicist. Perhaps Dr. Weyzen could answer this.

Mr. **Carter**. Yes, I would like to hear from him.

Dr. **Weyzen**. Current levels for occupational exposure are 3 rem per quarter, or 5 rem total per year.

Mr. **Carter**. Five? Repeat that again, please.

Dr. **Weyzen**. Three rem per quarter, or five rem total exposure per year.

Mr. **Carter**. Five per year?

Dr. **Weyzen**. Right.

Mr. **Carter**. What is the permissible daily dose?

Dr. **Weyzen**. I would have to make a quick calculation.

Mr. **Carter**. All right, you would have to divide 3 rem by 90 days, I guess. Wouldn't that be it?

[Dr. Weyzen nods affirmatively.]

Mr. **Carter**. Do you monitor these people who work at Hanford, Wash. fairly regularly?

Dr. **Liverman**. The people at all of our plants wear film badges if there is any possibility of exposure to radiation, not only Hanford but all the others. I do not know how often they are developed. I suspect about monthly. At least that was the procedure when I was at Oak Ridge for a while. And if you had any darkening of the badge at all, you got called in and asked, where you had been, what you were doing.

Those who are in high radiation level areas have dosimeters other than a film badge.

Mr. **Carter**. On page 4, you stated the only information available on human radiation exposures in humans stems from the study of the A-bomb survivors in Japan and other studies which pertain to acute exposures. Would you please identify what those other studies were?

Dr. **Weyzen**. In addition to the study of the Japanese survivors, information on the effects of radiation came from the study of the radiologists, for instance.

Mr. **Carter**. Could you respond also, Dr. Liverman? I didn't completely understand his answer.

Dr. **Liverman**. In addition to the exposures of the Japanese to the atomic bombs, there are studies of radiologists that were carried out in the United States. These were external exposures. There clearly have been other exposures, like the radium dial painters, which have been followed for many years by Dr. Robley Evans. That is different. That is internal exposure.

There are a number of others reported by the United Nations committee (UNSCEAR). I cannot recite them. They are certainly matters of record.

Mr. **Carter**. Are you familiar with the atomic bomb tests at Yucca Flats in Nevada?

Dr. **Liverman**. I am familiar only with the fact that I read of them in the newspapers, and yes, they happened, but I have no more familiarity than that.

Mr. **Carter**. You were not with the Atomic Energy Commission at that time?

Dr. LIVERMAN. I don't remember the precise time of the tests, but I was first with the Atomic Energy Commission from 1958 to 1963, and then I was out of it for a while, but I had no responsibility whatsoever for anything to do with the testsites.

Mr. CARTER. What do you have to say about Dr. Alice Stewart's pioneering work on in utero exposures to radiation?

Dr. LIVERMAN. That work, as evaluated by the scientific community, is usually attributed to be outstanding.

Mr. CARTER. I will agree on that. What about the studies on radiologists of the effect of ionizing radiation?

Dr. LIVERMAN. I would have to refer that question to Dr. Hutchison, who is in some degree more familiar. George, can you speak to that study?

Dr. HUTCHISON. There are two such studies, the early study by Dr. Shields Warren, and the more recent study by Dr. Sartwell and his colleagues at Johns Hopkins University. The latter study is generally accepted as a most excellent study.

Mr. CARTER. What were the results of those studies, please?

Dr. HUTCHISON. The results of both of the studies—and it is of some interest that the results are the same, but I will pass that for the moment—the results of those studies were that radiologists exposed in the early years of the century had a clear increase in cancers of a number of sites, and I do not have the details of that with me at the moment. Certainly leukemia was——

Mr. CARTER. To what year did the study go?

Dr. HUTCHISON. I do not have, again, the date.

Mr. CARTER. 1969, I believe.

Dr. HUTCHISON. I believe that is the latest date, but I was starting to comment on the different observations of the earlier years and the later years. The excess has been seen only in the radiologists who have been exposed in the earlier years of the century, and in the later years, and I am sorry I do not remember the exact date of this break—I think it perhaps is 1940 or 1945—and after whatever this date is, in their analyses, the later radiologists have shown no effect.

Mr. CARTER. What was the increased incidence of leukemia among radiologists until 1969?

Dr. HUTCHISON. I don't have the numbers at hand, sir.

Mr. CARTER. I believe it was 2½ times normal. Were these high-level or low-level exposures?

Dr. HUTCHISON. These were presumed to be low-level exposures over a long period of time.

Mr. CARTER. What other tumors besides leukemia were found since 1969?

Dr. HUTCHISON. Among the radiologists?

Mr. CARTER. Yes.

Dr. HUTCHISON. My recollection is that there were no excess tumors, either leukemia or others, in the radiologists who were exposed only since whatever the breaking period is.

Mr. CARTER. There was an excess of solid tumors 2 to 2½ times among radiologists compared with other physicians.

Dr. HUTCHISON. I am sorry. I didn't understand.

Mr. CARTER. I believe the excess of solid tumors was found to be 2 to 2½ times as frequent among radiologists as other physicians.

Mr. **Carter**. That is not limited to 1969, it is my understanding, sir, so we see that there is a relationship, there is an undeniable relationship between ionizing radiation and the causation of cancer as you have freely said, and really, we do not know the level, a safe level, so we?

Dr. **Hutchison**. As I say, I assume there is no safe level, sir.

Mr. **Carter**. In many cases, there is a latent period, is there not?

Dr. **Hutchison**. Yes, that is correct.

Mr. **Carter**. What is the extent of this latent period?

Dr. **Hutchison**. For the leukemias, it appears to be very short, probably 2 or 3 years. Extra leukemias were seen in the atomic bomb survivors very early after 1945. In most other sites it ranges from 10 to 20 years; several sites have——

Mr. **Carter**. Up to 20 years?

Dr. **Hutchison**. Yes, before the first signs are apparent.

Mr. **Carter**. A latent period of up to 20 years. So from 1957 until 1977, last year would be exactly 20 years from the atomic explosion at Smoky. Since that time, of the 447 cases checked there have been 8 cases of leukemia found by Dr. Glyn Caldwell in CDC. Would you consider that statistically significant?

Dr. **Hutchison**. This was 8 in 440 people who had been observed for 20 years?

Mr. **Carter**. 447. There was something over 2,225 soldiers there. The Center for Disease Control has the records. They have gone over them. The last time I heard, 447 have been located and of those 447, 8 are proven to have leukemia, and the age group of the men exposed generally is 40 to 44.

Dr. **Hutchison**. My quick calculation, which may well be in error, is that this is 1 in 1,000, and one expects 1 in 10,000, so this would be an increase on the order of tenfold. I could have made an error of tenfold in my calculation.

Mr. **Carter**. But you would say that would be an increase of tenfold? You have told me exactly what I wanted to know, and I want to thank you, because it means a lot to those men who were exposed and who are now developing leukemia. In my opinion, Dr. Glyn Caldwell of CDC has shown through his epidemiological research that these men developed their leukemias as a result of exposure to ionizing radiation at Smoky. Thank you, Doctor. You are a good man.

Mr. **Rogers**. Mr. Walgren?

Mr. **Walgren**. Just to make sure we get the arithmetic straight, am I advised right that 8 per 447 would be 19 per 1,000?

Dr. **Liverman**. That is about right.

Mr. **Walgren**. Rather than 1 per 1,000, and therefore you would have 190 per 10,000.

Dr. **Hutchison**. These people were exposed for 20 years. That is 8 in 440 times 20 years, if I understand the exposure. Is that correct? There were 440 people who were exposed 20 years ago?

Mr. **Walgren**. Apparently we are comparing a single exposure with a long time, 20-year exposure. Is that correct? You expect 1 per 10,000 in a 20-year exposure rate. Is that correct?

Dr. **Hutchison**. No, 1 per 10,000 per year is the general population rate.

Mr. WALGREN. So you would get 20 in 20 years if you got 1 for 12,000?

Mr. CARTER. If you would yield for an observation, I believe in this age group, from 40 to 44, the expected incidence is 4.1 per 100,000.

Dr. HUTCHISON. That would be about 1 in 25,000 insteadof one in 10,000. That is the standard rate, is it?

Mr. CARTER. Yes, sir.

Dr. HUTCHISON. So that would be 1 in 25,000 instead of 1 in 10,000, as the expected rate.

Mr. CARTER. For this age group?

Dr. HUTCHISON. Yes.

Mr. WALGREN. Just very brief arithmetic, we are getting 8 in 500, and that would be—well, let's leave the record open at this point for calculations.

Mr. ROGERS. Would you like to speak?

Mr. JABLON. I am in the position of having once made the calculation, not for 500 but for 2,000. Someone had told me that the denominator was 2,000, and I had calculated it for that group. The expected number would be of the order of 2, so if the number is really 500, the expected number at population rates would be in the order of one-half a case, and if 8 in fact have been observed, and if 500 is the right denominator—I leave the division to you, sir.

Mr. WALGREN. It would give you something in the range of 16 times the expected amount?

Mr. JABLON. My arithmetic is the same as yours.

Mr. WALGREN. I just wanted to explore this quickly. Dr. Gilbert, I understand that you compared the rate of various incidences in the Hanford workers with the rate of similar incidences in the population as a whole.

Dr. GILBERT. That was one type of analysis we did, yes.

Mr. WALGREN. It is also my understanding that the Hanford population is a very unique population. It is screened for both age and health.

Dr. GILBERT. I made that point in my testimony.

Mr. WALGREN. So that any extrapolation to the population as a whole would not really hold, and we ought to be looking for a much more sensitive method of comparison.

Dr. GILBERT. You are right. That is why we did the exposure analysis. This was considered only to provide a certain amount of perspective.

Mr. WALGREN. To provide a certain amount of perspective?

Dr. GILBERT. This was done to provide perspective, but we would regard our primary analysis as that analysis which relates death rates to the exposure that individuals had received.

Mr. WALGREN. You know, one of the difficulties in this, I suppose I will admit to my own biases, but I remember when I was a 10-year-old I broke my arm, and I was X-rayed by the sweetest radiologist I ever knew, and the man died at the age of 45 from leukemia, and when I see the people who were previous witnesses at this hearing coming forward and saying that their evaluation of the effort that was worth putting toward tracking down the low exposures of those troops that they had marched under the atomic radiation exposures—in their terms that was worth one-quarter of one man's time per year—I wonder about the perspective of the people involved in this, and I specifically wonder if something like that is obviously not a good comparison.

What kind of perspective would you want from them?

Dr. GILBERT. I am not certain what you are asking, sir.

Mr. WALGREN. I wonder, when we do have testimony on the record this morning from Dr. Mancuso that he was led to believe that it would be much easier to get his next year's consecutive funding if the results were negative, I wonder what sort of perspective we are looking for, and what you are telling me is that you ran a calculation which I would not say is useless, but what perspective were you looking for from a calculation that you knew would not give you an accurate comparison?

Dr. GILBERT. As I say, I regard our primary analysis as the one in which we consider the radiation exposure. However, in doing this, you are comparing high exposure workers, say, with lower exposure workers, and the question arises, well, are those lower exposures unduly high or unduly low? If you know the low exposure group had, say, higher death rates than the general population, that would throw things in a different perspective when you made the internal comparison than if you knew that they were low.

Mr. WALGREN. Would it not be feasible to compare that group with an occupational group that was not exposed at all?

Dr. GILBERT. It is very difficult to come up with a control group that is really comparable. Either they are in a different location or they have other exposures that may be biasing things. Furthermore, it is far more expensive to have to develop all this data then to use data which are available for the U.S. population.

Mr. WALGREN. Do you know whether in grappling with this problem ERDA made any effort to find a proper control group?

Dr. GILBERT. Yes; in the initial stages they had used siblings as a control, and I believe Dr. Sanders has analyzed the sibling data and found no differences in mortality. If anything, I believe the Hanford workers had slightly more favorable mortality than their siblings.

Mr. WALGREN. Is that the only effort you know of to come up with a more comparative control group?

Dr. GILBERT. I believe there was some effort to establish Social Security Administration controls. This was eventually dropped, I believe.

Mr. WALGREN. I understand you found a death rate of 75 percent of the population as a whole among the Hanford workers.

Dr. GILBERT. Correct.

Mr. WALGREN. And a cancer rate of 85 percent of the population as a whole among the Hanford workers.

Dr. GILBERT. Right.

Mr. WALGREN. Would that not indicate that the cancer rate is occupationally elevated at Hanford?

Dr. GILBERT. I don't believe so. You can look at many different employee populations and find a similar type of thing. Things like health programs, pre-employment physicals, and so forth, may have played a far more important role in something like cardiovascular disease than cancer. There is not a tremendous amount that people can do about cancer, so that these factors just do not affect cancer to the extent that they affect certain other diseases.

Mr. WALGREN. Just briefly, I wanted to turn to the reasons that Dr. Livermore gave to the transfer of the study. On what date, Dr. Livermore, did you decide to transfer the study?

Dr. LIVERMAN. My name is Liverman, sir. The Livermores are the richer side of the family.

I would be hard put to remember the precise date. I do remember that the memorandum from the staff was dated in December 1974, and that I acted on the basis of that. The issue brought to me was, that the staff felt that the project should be terminated. My response was that the project must go through our research committee review, which is an internal mechanism, and have external review also. The report which Dr. Mancuso mentioned, which is in the files we provided you, dated, I believe, the 8th of January, was the document that finally decided the issue to terminate the program.

Mr. WALGREN. January 1975?

Dr. LIVERMAN. I believe that is correct.

Mr. WALGREN. It was well under way in December 1974, when there was a memorandum recommending transfer of the program, according to your testimony.

Dr. LIVERMAN. That is correct.

Mr. WALGREN. One of the reasons behind that was apparently the reluctance to initiate any analysis until all data collection was complete, so in December 1974, we have the Government supervisors indicating that a reluctance to initiate any analysis until all data collection was complete as a factor in their decision to transfer the project, and yet, according to Dr. Mancuso, on page 19 of his statement, there is substantial data that was not received by December 1974; to wit, the data on years of external radiation exposure from 1944 to 1975 was not received until September 1976.

Further data on years of external radiation exposure from 1944 to 1974 was not received until November 1975. Years of external radiation exposure, 1944 to 1973, was not received until January 1975. Years of internal radiation exposure up to 1974 was not received until March 1976. Environmental exposure records were not received until March 1977, all after the decision supposedly was made in December, 1974, to transfer this because he was unwilling to initiate analysis.

Now, how can you initiate analysis when you have no data to work from or no complete data to work with?

Dr. LIVERMAN. There is a difference between complete data and just data. I think that those who are more familiar with the precise details of those issues are far better qualified than I to deal with the question. However, I do know that there were detailed peer reviews extending over a long period of time, which are now in the possession of the committee. It is the summation of those peer reviews over that period of time which I understand formed the background for the recommendation they brought to me.

I cannot speak with any degree of certainty about the delivery of data to Dr. Mancuso. Members of my staff who directly supervised or worked with those matters would have to provide that information to you.

Mr. **Walgren.** Was Dr. Mancuso ever given an opportunity to comment on those adverse peer reviews?

Dr. **Liverman.** I can't answer that.

Mr. **Walgren.** If you made a decision based on that, don't you believe you should be able to answer that question?

Dr. **Liverman.** You are perhaps correct. In retrospect that is certainly true.

Mr. **Rogers.** May I interrupt at this point? There is a vote. The committee will recess for 10 minutes.

[Brief recess.]

Mr. **Rogers.** The subcommittee will come to order, please. People, please take your seats. We need order to proceed, please.

Mr. **Walgren.** Thank you, Mr. Chairman.

As to the stated reason for terminating a contract that results had not been published, is it not true, Dr. Liverman, that expressed statements were made in the evaluation of the study by personnel that credit should be given to Dr. Mancuso for not publishing earlier, to wit, on page 17?

Dr. **Liverman.** What document are you reading from, Mr. Walgren?

Mr. **Walgren.** ERDA internal memorandum dated January 8, 1976, in paragraph——

Dr. **Liverman.** I don't have that in front of me.

Mr. **Walgren.** I will read it to you. Under Evaluation it says:

> This contractor has also refrained from drawing premature conclusions when early results have indicated that some effect may be present. He has properly accepted those results as leads for further inquiry, and in the process has discovered biases which account for the results. Since such biases are apt to creep into some portions of the data in a study as large as this, patience in checking out results is desirable.

Now, that would lead me to believe that those who evaluated this program within ERDA certainly understood Dr. Mancuso's reluctance to publish—I take that back—reluctance to analyze the data at a premature time.

Dr. **Liverman.** I think no data should be analyzed at a premature time. I certainly agree with that. There is perhaps some difference of opinion as to whether or not Dr. Mancuso had adequate data on which to carry out analyses. I am looking at a letter dated June 27, 1972, from Dr. Mancuso to Dr. Totter, who was then the Director, Division of Biomedical and Environmental Research, and I quote to you, "We deem our findings, even at this stage, as highly significant to many of the fears expressed about the health hazards to persons exposed to even low levels of radiation."

Yet it was 4 years later before a thorough scientific paper came forward out of it. It is not by way of defending my staff or anything else. But it simply says, certainly, if he could conclude what I have just quoted in 1972, there should have been a adequate paper published for other people to criticize and review by 1974, when the decision was made, or early 1975, and certainly before September of 1976.

Mr. **Walgren.** Reading from a letter of Dr. Weyzen dated March 29, 1977——

Dr. **Liverman.** Is this to Dr. Mancuso or the earlier letter to someone else?

Mr. Walgren. It is to a Dr. Borchman, where Dr. Weyzen says, "Most forms of cancer have latency periods up to several decades. The process of data collection on each individual in the population requires a thorough search of all available records. Consequently, it would have been extremely difficult to conduct meaningful analysis at an earlier time."

My point is simply this. I am looking for some solid reasons for transferring this study from Dr. Mancuso, and what I am finding in the Government agency is bald statements in conflict with the reasons you gave.

~~Dr. Weyzen~~. Mr. Chairman, if I may, it might be useful to describe very briefly the type of work conducted in the period since 1964. It was not until——

Mr. Walgren. Let me ask you briefly, is not that statement in conflict with the reasons that have been given for Dr. Mancuso's termination?

Dr. Weyzen. No, sir, it is not, and I was trying to explain that.

Mr. Walgren. All right, proceed.

Dr. Weyzen. It was not until 1974, I believe, that Dr. Mancuso got engaged in the analysis of the cause of death of the Hanford population. Prior to that time, all analyses of which I am aware were done on longevity of the population, and the quotes just read by Mr. Walgren refer to an analysis of longevity of workers, not the mortality. Mortality, that is, cause of death, was not initiated until very late in the study, probably sometime after Dr. Milham wrote his paper.

Dr. Liverman. Mr. Walgren, I think if I may make a comment here, it seems to me that one way to get to the heart of the matter would be to ask Dr. Marks, who was, for many years, the project officer on this program. Many of the actions we took were based on his scientific recommendations and judgements which were in large part based on the peer reviews which I delivered to the committee this morning. Perhaps he can more responsibly and accurately answer the questions than can I. Certainly I am not familiar in detail with each of the 1,500 projects that fall under my general purview.

Mr. Walgren. Did you essentially rely on Dr. Marks in making the decision?

Dr. Liverman. On Dr. Marks and the recommendation of the scientific review committee within the agency. That is where I depend most of the time for judgments about the scientific excellence or non-excellence for the programs. With 1,500 individual projects, there is not much else one man can do than to rely upon his staff to bring these matters forward.

Mr. Walgren. So you substantially relied on Dr. Marks——

Dr. Liverman. Yes.

Mr. Walgren [continuing]. In making this decision?

Dr. Liverman. And the research committee.

Mr. Walgren. So then that goes to Dr. Mark's motivation in whatever his analysis was, which we may be able to get at in some other way. I want to go back to one other point that you cite as the reason or one of the reasons in the dismissal of Dr. Mancuso, and that was, as you say, a clear lack of substantive publications appearing in reference journals on his methodology for analysis.

Now, we can quibble about what puts something out into the public, but I would think that that statement is at least substantially undercut by the publication in the proceedings before the Health Physics Society symposium in 1971, where Dr. Mancuso did publish a substantial document entitled, "Study of the Lifetime Health and Mortality Experience of Employees of AEC Contractors, Part One, Methodology and Some Preliminary Findings, Limited to Mortality for Hanford Employees."

In fairness, I guess I should give you the opportunity to explain why this [indicating] did not qualify as a publication.

Dr. LIVERMAN. In general, in the scientific community, the procedure one follows to publish a paper, and I believe my word "substantive" would relate to that precise definition you are talking about, is to prepare a publication, then have it reviewed by peers who are experts in that area, commented upon in detail, the comments taken into account by the investigator, and then published. That is the process by which most scientific papers get published. I do not believe, although I have no specific knowledge concerning this particular paper, that it would have been one that underwent, as so others, a thorough scientific evaluation by one's peers.

It is from that kind of evaluation that we must ultimely rely upon the validity of all the scientific results. I am not questioning the validity of the paper itself, but, in general, that is the way the scientific community validates the work of its body of scientists.

Mr. WALGREN. Which source did you rely on to make the judgment that Dr. Mancuso had not published in a forum that would create the kind of evaluation you were seeking, Dr. Marks or the scientific review committee?

Dr. LIVERMAN. Both.

Mr. WALGREN. Both said that to you?

Dr. LIVERMAN. May I describe the scientific review process for you?

Mr. WALGREN. Yes; if you can keep it brief, because I am trying to keep a record that is understandable.

Dr. LIVERMAN. When a proposal comes into the environmental part of the Department of Energy we assign and individual to be responsible for seeing that proposal through the review process. The proposal is reviewed by a group of people, some of whom have expertise in the proposal's area of science and some of whom do not.

In addition, the proposals are sent to people in universities, our laboratories and elsewhere for their inputs and opinions. That comes back. The proposal is then processed. The document that you have, dated January 8, 1976, was a summary prepared in that case by Dr. Marks for a review of the proposal by the Scientific Research Committee, which consists of a number of the scientists in the environmental program. They review the proposal in detail and subsequently arrive at certain evaluations and judgments.

So, it is not the opinion of only a single individual acting upon a proposal. It is but a collective opinion based on internal and external reviews of what action should be taken regarding a proposal's scientific excellence. Whether a study is relevant or not is a separate decision depending on how closely it is related to the agency mission. There is absolutely no question, in the case of the work we are discussing that it is highly relevant, as this subcommittee and I well recognize. However, the scientific excellence of a proposal is judged by a group, not by a single individual, except in rare cases.

Mr. **Walgren**. I would simply question whether, when we have letters being written by ERDA officials, particularly referring to the letter from Dr. Weyzen, again, saying things like, "Consequently, it would have been extremely difficult to conduct meaningful analysis at an earlier date," that the failure to publish was a substantial reason for the transfer of that material.

Now, that is only a conclusion of mine, and one that is admittedly subjective.

I want to go to one other point which you raised in terms of the reasons given for transferring the study, and that is, "The need from the agency's standpoint to insure that the records constituting the study could be preserved." Did you ever raise with Dr. Mancuso the need for preserving the records?

Dr. **Liverman**. I never, personally, raised that question with Dr. Mancuso.

Mr. **Walgren**. Given the alternatives available to preserve the data, it certainly looks from this side of the bench that that reason, as is given, for supporting the transfer of a study of this kind is bunk.

Dr. **Liverman**. May I speak to that question? Not only with regard to that particular study, but let me give you an analogous example. There exists in one of our laboratories a 20-year experiment on the exposure of large populations of mice to radiation. The principal investigator has been very reluctant to make his raw data and his background information available so that others, too, may analyze them.

We have had to take the position that he must. In the same context, for the materials gathered in the Atomic Bomb Casualty Commission, which are in Japan, we have insisted that the data there be duplicated at least three times so that it is not lost and can be analyzed by a lot of people.

The same sort of consideration, I believe, applies to Dr. Mancuso or any investigator who has large masses of data like these.

Mr. **Walgren**. At this point, Mr. Chairman, we will leave the record open for Dr. Liverman to supply the committee with the formal request that the agency made concerning preservation of data. I would expect that there would be submissions at this point in the record.

Dr. **Liverman**. May I clarify the request? You are requesting that if in fact the agency did write to Dr. Mancuso—is this the individual we are talking about?

[Mr. Walgren nods affirmatively.]

Dr. **Liverman**. And asked him, could he, or would he preserve the data—is that the nature of your question?

[Mr. Walgren nods affirmatively.]

Dr. **Liverman**. Fine. We understand that.

Mr. **Walgren**. Thank you, Mr. Chairman.

[Testimony resumes on p. 694.]

[The following material was received for the record:]

June 12, 1967 AEC 1136/1

ATOMIC ENERGY COMMISSION

CORRELATION OF EXPERIENCE OF EMPLOYEES WITH RADIATION EXPOSURE

Note by the Secretary

The General Manager has requested that the attached memorandum of June 6, 1967 from the Directors, Divisions of Biology and Medicine and Operational Safety, with attachments, be circulated for the information of the Commission.

W. B. McCool
Secretary

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UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

JUN 6 1967

MEMORANDUM FOR CHAIRMAN SEABORG
COMMISSIONER JOHNSON
COMMISSIONER NABRIT
COMMISSIONER RAMEY
COMMISSIONER TAPE

THROUGH for GENERAL MANAGER Donald C. Kull

SUBJECT: THE PURPOSE, NATURE AND PROGRESS OF THE CORRELATION OF LIFETIME HEALTH AND MORTALITY EXPERIENCE OF AEC AND AEC-CONTRACTOR EMPLOYEES WITH RADIATION EXPOSURE

On June 27, 1963, AEC STAFF PAPER 1136*on the subject, "Correlation of Lifetime Health and Mortality Experience of AEC and AEC Contractor Employees with Occupational Radiation Exposure," was circulated by the Secretary. This project, with your concurrence, is entering its fourth year under contract with the University of Pittsburgh School of Public Health. This memorandum is to update and report the study as to its purpose, nature, progress to date and immediate forthcoming activities.

The initial feasibility phase of the study was undertaken in view of the prevailing uncertainty of the nature and extent of biologically harmful effects, if any, on healthy humans from low levels of ionizing radiation. After the first year it was determined that a study would be feasible especially if it were limited to death rates.

During the past two years a pilot study has been underway at Hanford, Oak Ridge Union Carbide (including the former Manhattan Engineer District), certain feed mills, and the Universities of Chicago and California, and Columbia University personnel who worked at Oak Ridge for the Manhattan Project. The pilot study was designed therefore to ascertain the problems, limitations and potentials, and to determine the most effective coordination of methods: in effect, the feasibility of extending the study to other AEC-contractor facilities.

The study is an attempt to assess any lasting effects on the basis of differential survival rates and causes of death that may be observed between exposed individuals and appropriate controls followed in cohorts over many years until all the exposed individuals and the controls have died. For more details on methodology, see Appendix A.

Secretariat Note: *Approved by the Commission at Meeting 1947 on July 3, 1963.

In the installations included in the pilot study the AEC and its contractors have employed from 1943 to date some 150,000 persons. The method of study selected is a longitudinal follow-up of all production employees who could have been exposed to ionizing radiation in certain installations with appropriate controls (who could not have been exposed) to ascertain comparative survival rates and differential causes of death between the exposed and the controls.

The exposed groups and the various categories of in-plant and out-of-plant control groups (all in separate categories) will be subdivided into appropriate quinquennial or decennial age, and race and sex groups. Each subgroup with appropriate controls will be characterized as a cohort of a specific year in which the index individuals (index individuals are all the production employees of a given AEC installation) were first employed. Each cohort and its respective matched controls will be followed year after year and their respective survival rates from each year to the following year compared for controls as against the index groups to determine statistically significant differences, particularly for the groups with maximum exposure to radiation.

For the deceased, death certificates will be obtained, and causes of death for each year for the experimental groups will be compared with appropriate control groups again to ascertain whether there are any statistically significant differences between the exposed and the non-exposed.

The Atomic Energy Commission has exercised maximum caution to keep the exposure of employees to various sources of radiation to a minimum. Therefore no more than approximately 10 percent of the employees in various installations have had any measurable exposure to any form of ionizing radiation as a consequence of their employment. This suggests the necessity of extending the study to other AEC installations. (See Appendix B.)

The early extension to other AEC installations is also regarded advisable because of the fact that the men who participated in the early development of these plants could fill in gaps in information and could aid in the correct interpretation of the findings from different installations; this resource will not remain available too long, and its quality fades with time.

To avoid the risk of attributing to radiation other industrial hazards present in various AEC installations, a careful study of industrial exposure to such hazards by specific employees in specific plants is being made as an integral part of the present study. These include exposure to mercury, beryllium, asbestos, etc. In this analysis the possibility of synergistic or the inhibiting effects of various industrial toxicants with each other or with radiation would also have to be considered to avoid possible erroneous conclusions. This is one of many reasons why in this analysis each installation would be analyzed and treated as a separate entity - a separate "experiment." No merging of different installations in the early phases of the study is contemplated.

It would be impossible to assess correctly the biological effect of radiation on man unless exposed individuals are followed for as long as they live. This is essential to ascertain possible latent effects 30, 40 or 50 years after radiation. To assure such continuity it would be desirable at some later date for a follow-up center for AEC to be established for the purpose of long-term studies of human populations exposed to radiation. It is anticipated that the following alternatives will be considered:

1. an AEC-contractor facility
2. a university
3. a development of a consortium of Atomic Energy industries which would provide joint sponsorship, funding, staffing and operation
4. AEC staff function
5. a group such as the National Research Council which has experience with such long range follow-up studies.

The uniqueness of the AEC population study is the totality of the population who were exposed to measured levels of radiation, incident to their occupational pursuit over the years. It is essential that each component, representing the population and radiation exposures of each facility, be accurate and complete and maintained with the same degree of thoroughness and concern.

The physical location of the study records in one location would simplify the necessary professional recordkeeping, the necessary cataloging, indexing, etc., coordinated effort to be ultimately used in a modern record system, such as conversion to tape or similar subsequent developments.

At this stage, one cannot determine what future observations may develop, which may warrant further information from the source data, relating to some particular substance, which would be meaningful only if all data from all the installations in the project were available for study.

The work to date has included the transfer of personnel identification and work experience data to about 20,000 record forms at Hanford. This phase of our work in Hanford is to be completed within the current fiscal year. Ten thousand forms have been finished at Oak Ridge, and about 25,000 more remain to be completed for employees of Union Carbide; in addition, there are over 50,000 more of Tennessee Eastman, and Monsanto records to be finished. Ways are being explored to accelerate the work at Oak Ridge so as to accomplish this phase close to the end of fiscal year 1968. Arrangements are being completed to record personnel information from other installations that are included in this preliminary phase of the study.

Radiation exposure records of all employees monitored for radiation exposure in Oak Ridge and Hanford have been cumulatively summarized and put on magnetic tape to be merged with personnel information when the record forms referred to earlier have been completed and put on tape. Radiation records for other installations are being worked on and should be completed long before the work on personnel records can be completed.

It is known, of course, that industrial exposure is not the only exposure to ionizing radiation. Background radiation and radiation incident to medical diagnoses and therapy are other sources of exposure. There is no way of knowing the extent to which these other exposures modify or distort the effects of radiation exposure based solely on industrial exposure installations. To remedy this ignorance, at least partially, advantage has been taken of the fact that in Richland, Washington, during the years 1946 through 1956, Hanford employees had almost all of their X-ray services from the Kadlec Hospital in Richland. As it turns out, the same machine which took X-rays in those days is still there, the same technicians and complete records of X-ray services received by the employees who worked at Hanford in those years. This study will allow the AEC to assess the relative contribution of medical occupational exposures to the total radiation exposure of this population. Tentatively it has been assumed that medical exposure and background exposure can be ignored in the assessment of the effect of occupational exposure since the two would be independent of each other. This study will test this assumption.

Charles L Dunham

Charles L. Dunham, M.D., Director
Division of Biology and Medicine

Martin B. Biles, Director
Division of Operational Safety

Attachments:
1. Appendix A
2. Appendix B

APPENDIX A

PURPOSE

The purpose of what will be referred to as a feasibility study is to close the gap in current knowledge regarding the biological effects of low irradiation on healthy human beings. It must be emphasized that there is still much uncertainty as to whether exposure to low level radiation has permanent harmful effects on man. A recent Public Health Service pamphlet[1] reads:

> "Scientists know a great deal about the effects on human beings of large doses of radiation -- such as would be encountered in a nuclear war, or amounts used in medical therapy to destroy cancerous cells. On the other hand, not as much is known about the effects of small doses of radiation, such as those to which all Americans are subjected -- natural background radiation and fallout from nuclear tests, for example. In particular, it is not known definitely whether there is a radiation dose or dose rate below which injurious effects will not occur. However, it is the consensus of scientific opinion that for purposes of health protection, the most prudent course is to assume that even very small amounts of radiation may produce some injury in a few individuals when large numbers of people are exposed."

The International Commission on Radiological Protection and the National Committee on Radiation Protection have repeatedly pointed out that none of the recommendations for lowering occupational exposure levels has resulted from the actual observation in humans of harmful effect at or below permissible levels of exposure. As the AEC has pointed out, much of the impetus for lowering permissible levels has come from extrapolation -- to lower doses and larger populations -- of information obtained on somatic and genetic effects at higher dose levels in smaller numbers of humans or animals, and from the subjective impressions of experts regarding the lack of an unfavorable health picture among atomic energy employees.

The AEC employees and the employees of AEC contractors provide the largest and most relevant body of recorded human experience with low level chronic exposure to ionizing radiation with which to test the possible harmful effects that may result from this type of exposure.

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[1] Biological Effects of Radiation, Public Health Service Publication No. 1538, Health Information Series No. 137, p. 2.

The resolution of the uncertainty that low level radiation may have leukogenic and carcinogenic effects on the individual and more general adverse effects on the descendants of those exposed to radiation is important for at least three reasons:

1) The world-wide scientific interest in the subject aroused by the atomic bomb and the associated fallout.

2) The situation could become medico-legally important, if precedence is set for aging employees and their survivors to sue the contractors for loss on the commonly held, though as yet unsubstantiated belief, that their early employment for AEC was the cause of certain diseases.

3) The expanding use of nuclear reactors as a source of power and growing technological uses of isotopes and transuranic elements, making it imperative for our society to ascertain what degree of safeguards are required to avert significant biological harm. During 1966 nearly one-half of the new installations for generating electricity were atomic plants and this trend will continue and accelerate rapidly in the years to come in view of the lower generating cost of nuclear fuels vis-a-vis fossil fuels, with the additional deterrent of air pollution, characteristic of all fossil fuels.

Method of Study

As indicated, a longitudinal approach will be used in which all production employees in various AEC installations who could have been exposed to ionizing radiation will be followed year after year with appropriate controls to ascertain comparative survival rates and different causes of death between those exposed to radiation and those not exposed. In this follow-up both in-plant and out-of-plant controls are to be used. The in-plant controls will consist of the following: a) persons who took the pre employment examination (medical) and were found eligible for work, who for one reason or other never worked in an AEC installation; b) persons who worked in AEC installations as production workers but have no record of ever having been exposed to ionizing radiation as a result of their employment. The exposed group itself, the strictly experimental group, will be subdivided according to the extent of exposure, the length of time over which exposed, and the time that has lapsed since such exposure to ionizing radiation occurred. The out-of-plant controls would be matched with individual employees in the plant. These controls will consist of: a) siblings of the same sex as the employee, and b) two independently matched controls selected from the one percent continuous work-history sample maintained by the Social Security Administration.

The employee group, whether exposed to ionizing radiation or not, will include all the individuals who at any time worked for any length of time in any of the installations that are included in the study. The analysis for each institution will be made separately from all other institutions.

The exposed groups and the various categories of in-plant and out-of-plant control groups all in separate categories will be subdivided into appropriate quinquennial or decennial age, and race and sex groups. Each subgroup with appropriate controls will be characterized as a cohort of a specific year in which the index individuals (index individuals are all the production employees of a given AEC installation) were first employed. Each cohort and its respective matched controls will be followed year after year and their respective survival rates from each year to the following year compared for controls as against the index groups to determine statistically significant differences, particularly for the experimental groups with maximum exposure to radiation. Moreover each year the survivors would be further subdivided and their frequencies compared between controls and experimental groups in terms of the following subcategories:

a) continuing in covered employment

b) disabled -- has filed a claim for disability or is receiving disability benefits

c) retired -- receiving or is about to receive retirement benefits

d) other

In any single analysis the cohorts in each sub-group will be retained as distinct throughout the analysis. However, different analyses will be made with different grouping and regrouping of the radiation exposed individuals such as according to the cumulative maximum dosage, according to the duration of exposure to radiation, according to the lapse of time since an early significant exposure to radiation, according to the exposure to other toxic substances in the work environment with and without radiation, etc. The matched controls would always be in homologous cohorts to those in which the index exposed individual is placed for comparison of survival rates, and if survived the probability of being in category a) "still in covered employment".

For former employees who have died and similarly for the controls, death certificates will be obtained, and causes of death for each year for the experimental groups will be compared with appropriate control groups again to ascertain whether there are any statistically significant differences between the exposed and the non-exposed. Again different groupings may be used to test possible duration of periods of latency and other possible hypotheses.

It is believed that this type of analysis carried over the years that have already elapsed, 1943-1967, would reveal any significant effect that ionizing radiation might have on survival or on causes of death in the first 20 to 25 years. At least it will be possible to say that the measurable effect could not be as large as a quantifiable maximum, consistent with the sample sizes, and as the study is carried forward until all the cohorts die out, this maximum would be progressively reduced to as close to zero as the time and resources will permit. Therefore eventually it should be possible to indicate the effect of radiation on longevity, and on causes of death, if at all significant.

Extension of Study

The extension of the study to other AEC installations is regarded essential to increase the volume of observation and the varying circumstances associated with radiation exposure. The study is not merely concerned with the determination whether or not there are any adverse biological effects from radiation, but if there are, the severity and nature of such effects, the underlying mechanisms, the differential effects of different modalities of radiation in relation to their penetrating nature, energy intensity, whether from external source or from internal emitters in different organs of the body, etc. To have any prospect of approximating these goals a large and varied exposure pattern is necessary. Fortunately for the country the Atomic Energy Commission has exercised maximum caution to keep the exposure of employees to various sources of radiation to a minimum. Therefore no more than about 10 percent of the employees in various installations have had any measurable exposure to any form of ionizing radiation. This necessitates obtaining the wide experience, which can be obtained only by extending the study to other AEC installations to ascertain what records are available and how they can be pieced together to give a fairly complete work history on each worker and information with respect to siblings of such workers as controls. Experience indicates that the specific difficulties of doing this are different at each installation and by delaying the gathering of basic data in other installations for another three or four years until this initial phase has been carried further nothing would be gained, but it could be costly to the project, since it has been learned that destruction of records has not been stopped. Moreover there are government-wide arrangements to transfer all "obsolete" files to government-wide centers. It has been found that when records are moved into such centers reconstituting them becomes well nigh impossible. Because of these circumstances an extension of the study to other installations listed in Appendix B is desirable. Such early extension to other AEC installations is regarded as advisable on another score: the men who participated in the early development of these plants could fill in gaps in information and could aid in the correct interpretation of the findings from different installations; this resource will not remain available too long, and its quality fades with time.

Follow-up Center

To arrive at definitive findings as to the biological effects of radiation on man, it is believed that a continuation of the study is essential for many years to come. The present importance of the question of biological effects of low level radiation will further increase in national significance, in the peacetime application of nuclear energy, which is becoming a major source of the power for the United States. The extent of the potential development of nuclear power will be augmented by the continuous observations which may be derived from the AEC follow-up studies. The magnetic tapes being developed of the source data of the AEC contractor facilities, pertaining to personnel, employment, radiation exposures, and other environmental factors can be analyzed and studied, utilizing the data processing facilities of a group with equipment and experience in long range follow-up studies. A parallel exists in the follow-up studies by the National Research Council with the Armed Services and the Veterans Administration.

There is a very large population and radiation data pertaining to the Armed Services and DASA, which will be followed up through the Veterans Administration by the National Research Council, which is of keen interest to the AEC study. Efforts have been made in this project for the development of a uniform system of identification and recording of data, so that individual and joint studies with the Armed Services can be undertaken. Observations derived in this manner may make significant contributions.

In addition the experience of the staff formerly associated with the Atomic Bomb Casualty Commission in Japan, would be extremely valuable. The additional knowledge and understanding of the broad spectrum of all environmental stresses is essential to any analysis of biological effects attributed to radiation.

The original source documents which remain and can be located of the MED and the AEC contractor installations should be stored in one location in the country. The present practice of disbursement to various federal record centers and other locations should be discontinued. Needless to say, any further destruction of these records should cease. This bears emphasis since changes in personnel throughout the country necessitates repeated effort to make everyone aware that there now exists a temporary cease-destruction memorandum pertaining to the records needed for the project, which apparently has not been effective. Extensive valuable records, irreplaceable records, were destroyed prior to the onset of the present feasibility study and such destruction has been going on since.

Despite efforts, there does exist variation in motivation and interest at each of the installations relative to the maintenance and retention of records. Individual contractors have no keen desire to retain the records but wish to have continuous access to these records for medico-legal purposes. It is recognized by the individual facility that the scientific use of these records requires study on a broader basis such as is now being conducted by the AEC in the present feasibility study.

The physical location of the study records in one location would simplify the necessary professional recordkeeping, the necessary cataloging, indexing, etc., coordinated effort to be ultimately used in a modern record system such as conversion to video tape or similar subsequent developments.

At this stage one cannot determine what future observations may develop which may warrant further information from the source data, relating to some particular substance, which would be meaningful only if all data from all the installations in the project were available for study.

It must be recognized that the present and projected AEC study may eventually constitute a valuable human counterpart to the extensive animal experimental carcinogenesis studies now under way on the combined radiation, and chemical and viral effects. At a subsequent stage of the AEC project, selected data from the medical folders will be abstracted for inclusion in the study, to test combinations of various factors.

It is necessary to appreciate what is known and not known relative to the long-term biological effects of radiation, as well as of other environmental factors. It has only been in recent years that occupational medicine has begun to recognize the need for the study of long-term biological effects for each of the various types of environmental factors in industry, and the number of studies of this nature are very few. Practically all of the previous work has been directed at what is referred to as the so-called acute effects, the immediate association of a cause and effect relationship that is demonstrated by an acute event and an immediate response. This is basic in the study of medicine and has been true historically in the field of occupational medicine where the association has usually been in terms of a short period of relationship.

In recent years, interest has shifted from the acute effects to the long-term effects and the fact is beginning to be recognized that there may be marked delays in biological effects. This has been exemplified by studies in the area of occupational cancer; for example, the workers exposed to betanaphthylamine or benzidine will develop bladder tumors which may occur 15, 20 or 30 or more years after exposure. Similarly, individuals who have been exposed in the manufacture of chromates or abestos products, will develop lung cancer as long as 20 or 30 or more years later.

Another phenomenon which has occurred within recent years is the change in emphasis of the concepts of disease causation from single to multiple factors, i.e., various environmental chemicals or agents may enhance the development of a particular disease or biological effect and in some instances theoretically have an inhibiting effect.

This is mentioned because it has considerable bearing in the approach being utilized in this particular study. Basically, of course, the primary purpose has been that of being concerned with radiation and the range of radiation exposure of the population of the AEC contractors. However, it was readily recognized that in order to properly evaluate the question of radiation, it was necessary to consider all other environmental factors, in order not to attribute to radiation a biological effect which may be due to some other environmental factor. Associated with this, in the analysis of the data is the problem of false positive and the false negative observations which may occur in a study of this type, if one is not sensitive to the various variables which are involved. For example if the control population represents those individuals who have had no exposure to radiation and the population to which it is being compared is the study group which has been exposed to radiation, a difference may occur. However, if the non-radiation exposed group had included occupational groups which had environmental exposure, which might develop the same type of diseases (lung cancer or leukemia), then the control population would reflect this influence and have a much higher rate; consequently the difference between the observed and expected, that is, between the study cases and controls would be null, and this could, in effect, lead to a false negative observation. The specific point relative to this employee population is that other environmental factors have occurred during the work exposure, over the years, substances which also had a long-delayed biological effect of a similar nature to radiation.

Similarly the study employee population, i.e., those who have had exposure to radiation must be refined in terms of identification exposure to other environmental agents during the years of employment, e.g., if an individual has been exposed to radiation and had also been exposed to one or more other environmental factors. An individual may have been exposed to radiation, received his maximum amount of exposure then have been assigned to an area in which there was a definite and continuous exposure to mercury. However, if these individuals were classified solely in terms of radiation, and the exposure to mercury not identified, then observations relative to either liver or kidney might be attributed to radiation, where it is more likely to be due to the mercury exposure. If a group of the employee population has been exposed to radiation, and also exposed to beryllium, and if this population then should subsequently develop lung cancer or liver damage, it is highly probable, based upon the present toxicological information, that such a development would more likely have been due to beryllium rather than due to radiation. In this instance, a false positive observation would occur attributing to radiation a biological effect which may be due to another factor. The simple arbitrary division of the study population therefore into so-called exposed and non-exposed radiation groups, poses difficult problems of analysis unless all the factors are identified.

Progress to Date

The present inquiry to date has been limited to a study of the experience of employees in the three plants at Oak Ridge, Tennessee, the Hanford installation in Richland, Washington; the three universities, Chicago, California and Columbia which pioneered massively the early developmental work for atomic weapons, and eight feed mill plants. Procedures and forms have been developed to obtain as complete a personnel and radiation exposure record as possible on each and every employee who ever worked in these installations from the moment that the plant went into operation to date -- with provision to continue these records on magnetic tape from here on out.

With regard to records showing the type of information which is now being collected on every production worker who ever worked in any installation included in the study, frequent gaps have been found in the information as a result of destruction in the past of certain record forms. As already indicated, it is in part this continuing loss of information that has led us to urge the earliest possible expansion of the present inquiry to as many of the AEC installations as possible to avert further loss of significant information.

To date, the work has resulted in the completion of about 20,000 record forms at Hanford. This phase of the work in Hanford is to be completed within the current calendar year. Ten thousand forms have been completed at Oak Ridge, and about 25,000 more remain to be completed for employees of Union Carbide; in addition, there are over 50,000 more of Tennessee

Eastman, and Monsanto records to be completed. Ways are being explored to accelerate the work at Oak Ridge so as to complete this phase by the end of fiscal year 1968. Arrangements are being completed to record personnel information from other agencies that are included in this preliminary phase of the study.

Radiation exposure records of all employees monitored for radiation exposure in Oak Ridge and Hanford have been cumulatively summarized and put on magnetic tape to be merged with personnel information when the record forms referred to earlier have been completed and put on tape. Radiation records for other installations are being worked on and should be completed long before the work on personnel records can be completed. Effort is being made to establish a special research task force at Social Security Administration to supervise and expedite the tremendous volume of data, which will be processed continuously on employees, siblings, and controls, which presently total approximately 500,000. To avoid delay in collecting death certificates from individual states, the University of Pittsburgh School of Public Health has recommended and encouraged the National Center of Health Statistics of the PHS to set up a national alphabetical index of all deaths. This recommendation has been supported by other agencies. It is estimated that the most serious loss of time will occur in the searching for many thousands of death certificates in all the different states.

Medical Radiation Exposure

The burden of proof of adverse health effect of ionizing radiation on survival must of necessity depend on gradients of radiation exposure as determined from accumulated badge readings for monitored individuals. It is known, of course, that industrial exposure is not the only exposure to ionizing radiation. Background radiation and radiation incident to medical diagnoses and therapy are other sources of exposure. There is no way of knowing the extent to which these other exposures modify or distort the severity of exposure based solely on industrial exposure for which there are individual quantitative measurements from AEC installations. To remedy this ignorance, at least partially, advantage has been taken of the fact that in Richland, Washington, during the years 1946 through 1956, Hanford employees had almost all of their X-ray services from the Kadlec Hospital in Richland. As it turns out, the same machine which took the X-rays in those days is still there, the same technicians and complete records of X-ray services received by the employees who worked at Hanford in those years. This study will allow the AEC to assess the relative contribution of medical occupational exposures to the total radiation exposure of this population.

The assessment of ionizing radiation exposure of employees incident to medical X-rays was undertaken by the Hanford Occupational Health Foundation and the Battelle Memorial Institute. This aspect of the work is to be completed within the current calendar year. Tentatively it has been assumed that medical exposure and background exposure can be ignored in the assessment of the effect of occupational exposure since the two would be independent of each other. This study will test this assumption.

Social Security

Tentative agreement has been reached with Social Security Administration for the follow-up of the larger mass of civilian employees and their respective controls to determine the comparative survival rate of the exposed vis-a-vis other groups in different cohorts from 1943 to date.

APPENDIX B

POSSIBLE INSTALLATIONS FOR EXTENSION OF FEASIBILITY STUDY

Argonne National Laboratory	Chicago, Illinois
Bettis Laboratory - Westinghouse Electric Company	Pittsburgh, Pennsylvania
Dow Chemical Company	Rocky Flats, Colorado
General Electric Company	St. Petersburg, Florida
Goodyear Atomic Corporation	Piketon, Ohio
Idaho Operations Office Argonne National Laboratory General Atomic General Dynamics - Electric Boat Div. General Electric Knolls Atomic Power Power Laboratory Phillips Petroleum Company Westinghouse Electric Corporation	Idaho Falls, Idaho
Los Alamos Scientific Laboratory (University of California)	Los Alamos, New Mexico
Monsanto Chemical Company	Dayton, Ohio
Nevada Test Site Operations (Reynolds Electrical & Engineering Company)	Mercury, Nevada
National Lead Company	Fernald, Ohio
Sandia Corporation	Albuquerque, New Mexico
Savannah River Operations Office	Aiken, South Carolina
Lawrence Radiation Laboratory (University of California)	Livermore and Berkeley, Calif.
Union Carbide Corporation, Nuclear Division	Paducah, Kentucky

Mr. ROGERS. Dr. Liverman, what is your budget for health studies?

Dr. LIVERMAN. I would like to correct this for the record, since I am recalling from memory. Next week, when I appear before Mr. Brown, I will have to know that in detail, but this week I do not.

Mr. ROGERS. I thought you might have known it this week.

Dr. LIVERMAN. My budget in detail is split into about eight major categories. Human health studies is one, and if I am correct, Dr. Weyzen, our total human health studies budget in the agency is about $19 million for fiscal year 1978.

[Dr. Weyzen nods affirmatively.]

Dr. LIVERMAN. It is about $19 million. We have supporting animal studies, and those would probably be of the order of, what, $47 million?

[Dr. Weyzen nods affirmatively.]

Dr. LIVERMAN. $47 million out of a total budget of $258 million.

Mr. ROGERS. The other money goes to what?

Dr. LIVERMAN. We have about $51 million in environmental studies, ecological impacts of energy sources of all kinds.

By the way, an important point here, I think, in the nuclear area, there is a total of about $54 million in health, environmental, and other programs. In the nonnuclear areas for which I have responsibility in the agency, coal, solar, geothermal, and the others, it is the remainder of that.

Mr. ROGERS. That is for research?

Dr. LIVERMAN. Principally for research, although there is a responsibility I have to take remedial action for the Grand Junction Mill tailings that were put under houses. For that kind of thing, the budget is about $16 million out of the total.

Mr. ROGERS. What about human health?

Dr. LIVERMAN. Human health studies for nuclear is $13 million.

Mr. ROGERS. How much of that is devoted to the Japanese study?

Dr. LIVERMAN. $6 million of that.

Mr. ROGERS. Half of our funding goes to the Japanese study?

Dr. LIVERMAN. Approximately. If I had not negotiated with the Japanese Government 4 years ago, it would have been all of it, because the program is $12 million now, and they fund half of that program.

Mr. ROGERS. I believe you have just returned from Japan.

Dr. LIVERMAN. Yes, sir.

Mr. ROGERS. What were your findings there?

Dr. LIVERMAN. We were not over there to discuss scientific findings so much as the budget, the program, and who the new board members are.

If you would like to know the details of the scientific results, Mr. Jablon was also there, if I could call on him.

Mr. ROGERS. Just briefly and quickly, Mr. Jablon.

Mr. JABLON. Well, very quickly and very briefly, I can say that the incidence of cancer, certainly among those who received large radiation doses, is not decreasing, not for the solid tumors, at least. Additional specific sites are coming into evidence all the time. The leukemia rate among the survivors has been declining since its peak in around 1952, but is still not back to normal. It is quite low, but it is still above normal.

Mr. CARTER. If the chairman would yield on that, isn't it true that the incidence of leukemia was quite low before the bombs were dropped on Hiroshima and Nagasaki, and since that time the incidence of leukemia in Japan has been much higher than it was before?

Mr. JABLON. Mr. Carter, you are quite right in terms of reported cases. I think it is really quite uncertain to what extent leukemia was being accurately recorded on death certificates prior to the war, because most of these statistics are based upon death certificate diagnoses, and as the quality of diagnosis, as physicians' ideas change, rates change considerably. Now, what you say is actually a fact, however.

Mr. CARTER. Yes, sir. The Japanese are highly intelligent individuals, and it seems to me that they would be very careful in keeping records, just as we try to do here in the United States. However we have only had death certificates since 1911, I believe, throughout our country. Thank you.

Mr. ROGERS. Have you had more and more cancer reported in Japan?

Mr. JABLON. Yes, sir, and it may be of some interest—I am sure that Dr. Mancuso and Dr. Stewart would be interested to know—that I did have the privilege of talking to Dr. Ishimaru, who runs the Hiroshima and Nagasaki Leukemia Registries, and he showed me a first draft of a paper they have coming out on multiple myeloma, and for the first time now I am really prepared to say on the basis of enough cases to achieve statistical significance, that multiple myeloma is incresed in the survivors, at least in those who had more than 100 rads. So, there is that point of agreement between the Japanese studies and these, although, of course, the dose levels we are talking about are very different.

Mr. ROGERS. How do they know how many had 100 rads or more?

Mr. JABLON. We spent years and a lot of Dr. Liverman's money and Dr. Totter's before him sending field agents out into the field armed with prestrike maps, talking with individual survivors, spotting them, exactly where they were, what floor of the house they were in. The Oak Ridge Health Physics Group at one of the test shots—I hope not one of the ones you have been talking about—actually had mockups of Japanese houses with dosimeters inside so that they could measure shielding characteristics. They provided us with air-dose curves so that we could perceive from the point where somebody was what the air dose would have been to what shielding he would have, then to an estimate of what is called a tissue kerma in free air at the point where the survivor was, and we have accounts of all of these people, and this has been very expensive, I assure you.

Dr. LIVERMAN. As a matter of fact, the points fall on a curve, a typical curve that extrapolates to zero, so you will find the doses are alined along that axis, so the calculated dose, and what they got, and the biological effect would pretty much match. That is the point.

Mr. ROGERS. Well, we hope they do.

Dr. LIVERMAN. Well, at the higher levels.

Mr. ROGERS. But we are not sure about the lower levels?

Dr. LIVERMAN. We are still getting results.

Mr. **Rogers**. What about your Marshall Island studies? Do they show anything from low levels?

Dr. **Weyzen**. The exposures at the Marshall Islands were not exactly lower level studies.

Mr. **Rogers**. They were not what?

Dr. **Weyzen**. Low level studies.

Mr. **Rogers**. What about Utirik?

Dr. **Weyzen**. Utirik was an acute exposure of 14 rad whole body, which is a relatively high exposure.

Mr. **Rogers**. It would seem to be borderline for the studies that you are doing. What is it, 3 years allowed dose in one?

Dr. **Weyzen**. Are you talking about the number of tumors?

Mr. **Rogers**. No; I am saying it is what you would permit over a 3-year period, and you were saying it was given in one exposure at Utirik.

Dr. **Weyzen**. That is correct.

Mr. **Rogers**. Let me ask this. Was that fallout, I presume?

Dr. **Weyzen**. There are reasons to believe that fallout could have been involved, yes.

Mr. **Rogers**. Was that mainly external exposure or internal?

Dr. **Weyzen**. Both.

Mr. **Rogers**. Dr. Liverman, when did you come to the AEC?

Dr. **Liverman**. I came back in November of 1972.

Mr. **Rogers**. Then where did you go? ERDA?

Dr. **Liverman**. Yes.

Mr. **Rogers**. And now you are at DOE?

Dr. **Liverman**. Yes, sir.

Mr. **Rogers**. Are your responsibilities for health effects research basically the same?

Dr. **Liverman**. Yes; very much the same, except they have broadened a great deal from nuclear into covering the whole spectrum of energy technologies.

Mr. **Rogers**. Yes; now, is Dr. Weyzen the——

Dr. **Liverman**. He is in one of the divisions reporting to me. Dr. Weyzen is in the Division of Biomedical and Environmental Research as a program manager. That division has a deputy and a director.

Mr. **Rogers**. And it is his responsibility——

Dr. **Liverman**. Human health studies.

Mr. **Rogers**. Dr. Weyzen, how long have you been in that position? Were you before in ERDA and in AEC before that?

Dr. **Weyzen**. I joined the AEC in 1969, and I became program manager in September 1976, I believe.

Mr. **Rogers**. So you were here after the contract had been given, but picked up the responsibility for the Mancuso contract at that time?

Dr. **Weyzen**. At the time I became responsible, I am quite sure the principal investigator had been informed of the termination.

Mr. **Rogers**. By the time you actually took charge?

Dr. **Weyzen**. By the time I took charge; yes.

Mr. **Rogers**. So was it Marks who had responsibility for the Mancuso contract at the time it was terminated?

Dr. **Liverman**. Dr. Marks, are you here?

Dr. **Marks**. Yes; I am.

Mr. ROGERS. Would you mind coming to the table?

Dr. LIVERMAN. I would be glad to let him have my chair.

Mr. ROGERS. Dr. Marks, could you identify yourself for the record, please?

Dr. MARKS. Yes; I am Dr. Sidney Marks. I am an M.D. and a specialist in pathology. I, subsequently, had training in biostatistics, and I have a Ph. D. in that field. I practiced pathology in Richland, Wash., and then took the graduate program in biostatistics. Later, after a faculty appointment at the University of Maryland, I joined the staff of AEC in December of 1971.

Mr. ROGERS. 1971?

Dr. MARKS. Right. Then I left there in June of 1976 to return to Richland to serve on the Battelle—Pacific Northwest Laboratories staff, where I am associate manager for environmental, health, and safety research programs.

Mr. ROGERS. The decision to terminate the contract with Dr. Mancuso was basically your judgment, as recommended from the peer review group that you had heard from, and which you gave to Dr. Liverman?

Dr. MARKS. It was my decision arrived at jointly with the staff. The matter was referred to Dr. Liverman, Dr. Burr, who is deputy director of the division, and Dr. Edington, who was associate director for research and development, so that it was a joint decision.

Mr. ROGERS. What was the basis of the decision?

Dr. MARKS. The basis was the feeling that Dr. Mancuso had not performed adequately, which was based in part on the peer review opinions that had been offered during the course of peer reviews of the study.

Mr. ROGERS. Who were the peer reviewers? How many were there?

Dr. MARKS. There were five peer reviewers in November of 1972. There was a review in 1970 with two reviewers, another review in 1967 with, I believe, six reviewers. The early reviews were not as strongly critical of Dr. Mancuso as the later ones. Some of the earlier reviews were critical of the study in terms of wondering whether the study would produce the results that the investigators were looking for and which the agency was seeking.

Mr. ROGERS. Which was that?

Dr. MARKS. Which was to demonstrate radiation effects in the worker population, or to possibly rule out those effects.

Mr. ROGERS. On what date was the judgment made to terminate the Mancuso contract?

Dr. MARKS. In August of 1974, I drafted a memo which I can place in the record.

Mr. ROGERS. Yes; I wish you would.

Dr. MARKS. In that memo, I proposed that a set of programs relating to human studies be transferred to Oak Ridge Associated Universities. There were a total of about eight such programs under consideration. The health and mortality study was one of them, and the reasons the pros and cons were listed in that memo. The reasons were the performance of the contractor and the opinions of the peer reviewers. There was a feeling that the staff themselves were dissatisfied with the progress of the study and that the peer reviews had set the stage for this feeling that the study was not being carried out properly.

[Testimony resumes on p. 714.]

[The following material was received for the record:]

DISCUSSIONS AND RECOMMENDATIONS CONCERNING A PROJECTED ORAU PROGRAM OF HUMAN STUDIES AND RADIATION MEDICINE ACTIVITIES

This report considers initiation or transfer of the following activities to ORAU:

1. Development of an emergency treatment facility for radiation accidents including those involving personnel contamination.
2. Development of a training center for the handling by occupational physicians ~~in the nuclear industry~~ of medical problems resulting from radiation accidents.
3. Development of a registry of radiation accident victims.
4. Development of a radiation exposure registry for employees in the nuclear industry.
5. Development of a nationwide program of monitoring public health and demographic statistics in the neighborhood of contractor and licensee nuclear plants.
6. Development of a health effects assessment program.
7. Transfer of management and analysis in the Health and Mortality Study from the University of Pittsburgh.
8. Transfer of the U.S. Transuranium Registry from the Hanford Environmental Health Foundation.

The following recommendations are made relative to the individual activities listed above:

1. Radiation Emergency Assistance Center.

   The emergency treatment facility is endorsed as a highly desirable regional treatment resource. This facility could provide medical emergency backup to a large network of nuclear production and power plants in the southeast region. It would also become an important element of the training program discussed below in 2. Dr. Lushbaugh is superbly qualified to supervise this activity.
2. Radiation Occupational Medicine Training Facility.

   ORAU has ample experience in conducting training courses for industrial physicians in the handling of radiation exposures and accidents. It would be appropriate to make ORAU the central facility for training in occupational medicine in the nuclear field. The following components might be considered for inclusion in an ORAU program to be conducted in cooperation with the ORNL Health Division:

a. Serve as the sponsoring facility and possibly the sole location for the annual short course in the management of radiation accidents for industrial physicians;

b. Provide interim guidance or instruction to physicians who have need for educational assistance but have not attended the annual course;

c. Conduct occasional, more advanced symposia for experienced physicians and scientists in this field;

d. Become a reference center for current information concerning the management of radiation accidents, the treatment of radionuclide deposition [illegible] the occupational medical [illegible] populations;

e. Establish cooperative arrangements with medical institutions providing residency or other training in occupational medicine so that residents or fellows may receive part of their training at ORAU and ORNL.

3. Registry of Accidentally Irradiated Persons.

The "National (International) Registry of Accidentally Irradiated Persons" at ORAU, an outgrowth of the interests and experience of Drs. Andrews and Lushbaugh, is receiving funding at present. The Registry will obtain and maintain a file of follow-up information on victims of major accidents. Its further development should be strongly encouraged. This Registry will be a valuable asset to the training program and will be an important element in discharging an AEC responsibility to guarantee maximum utilization of any information that may be obtained on the effects of human radiation exposure.

4. Occupational Radiation Exposure Registry.

An industry-wide radiation exposure registry could be developed in collaboration with the ORNL Health Physics Division, utilizing the services of personnel like J. C. Hart, and the Oak Ridge Computing Technology Center. The purpose of the Registry would be to centralize the storage of radiation exposure information or access to such information in a single facility. The Registry could improve (a) the accessibility and completeness of past exposure records for those new employees in a plant who were previously employed elsewhere [illegible] industry; [illegible], and ease of [illegible]ation of [illegible] concerning radiation exposure in the industry; and (c) the quality assurance of radiation monitoring and relevant record keeping in the industry. The project could synthesize the following ongoing or projected activities:

a. the directory of radiation exposures formerly maintained by Mr. Eason in the Office of the General Manager, AEC;
b. the master roster of essential employment data, including periods of employment, for individual employees of the major AEC contractors. This activity is now being completed by Dr. Mancuso as a part of the Health and Mortality Study; and
c. the Radiation Workers Directory proposed recently by Mr. Hart of ORNL but not approved for funding as yet.

Additional discussion of the relationship of these activities to the proposed registry is provided in Enclosure 1.

A central administrative facility could address the following issues relative to a directory:

a. the potential categories of users and those user needs that may be served profitably by a directory;
b. the types of data that may be included in a registry at reasonable cost;
c. the manner of access to contractor or licensee data when not included in registry files; and
d. the mechanisms for and problems that may be encountered in pooling exposure data from a variety of employer sources.

This project would require health physics expertise on either a staff or cooperative basis. It would also encompass certain activities now performed or projected by others. Coordination with persons now conducting those activities or obtaining their participation would be essential. For these reasons, the project would require preliminary exploration by ORAU and the development of necessary working relationships with key persons discussed here as well as others before its feasibility can be evaluated.

5. Program of Public Health and Demographic Surveillance around Nuclear Plants.

A program of public health and demographic surveillance around nuclear plants, including power plants, if located at ORAU could take advantage of existing resources in ORAU and ORNL. The Southern Regional Demographic Group affiliated with ORAU would contribute directly to such a program. The census tract and other data resources of the ORNL Regional and Urban Studies Department of the Energy Division could be utilized in this program. Expertise in epidemiology with special emphasis on public health statistics would need to be brought to bear on this project. This and other projects considered here would justify the addition of epidemiologic and biostatistical personnel to the ORAU staff. In addition, the liberal use of expert consultants and advisory groups would probably be required in this project.

6. Assessment Projects.

The assignment to ORAU of multiple projects concerned with the effects of radiation on man could easily lead to the development of a health effects assessment project. If there is interest in developing this activity, it should be phased in gradually rather than have it initiated simultaneously with the impending change in orientation of the overall program and the startup of new activities.

Regional assessment is also a possibility in view of Dr. Johnson's background in ecology and his sociological interests. However, Dr. Johnson's probable preoccupation with administrative duties and the lack of an environmental sciences base in the organization would make ORAU an unlikely choice for a regional assessment program.

7. AEC Health and Mortality Study.

The collection and analysis of past data in the Health and Mortality Study (HMS) is approaching completion. The bulk of the contract work at the University of Pittsburgh should be phased out in three years. At that time analyses will have been completed for the Hanford, Oak Ridge and Mound Laboratory plants. A time lag for phasing out the present administration of this project by Dr. Mancuso of the University of Pittsburgh would enable ORAU to prepare adequately for the assumption of this responsibility.

Ongoing data collection for the Study is in progress at Hanford, Oak Ridge and Mound and is funded through the responsible AEC operating divisions. Expansion of this ongoing collection program to include all other major AEC contractor facilities has been discussed by staff of the Divisions of Biomedical and Environmental Research and Operational Safety in recent years. This program is considered essential to the early discovery of any adverse health effects that might occur in individual plants or in the industry as a whole. Its existence bears testimony to the quality of AEC concern for the welfare of workers in the industry. Furthermore, the Union Carbide Company has decided that the HMS data collected at Oak Ridge is sufficiently important to warrant its inclusion in legally acceptable, individual employment records.

The deep involvement of the ORNL Health Physics Division in the data collection at Oak Ridge and of the Oak Ridge Computing Technology Center in data processing and computation for the HMS make Oak Ridge a logical site for long-term centralized management of this AEC health surveillance function. ORAU could assume administrative responsibility for the data collection and for analysis at appropriate intervals. Epidemiological and statistical personnel on the ORAU staff would be expected to contribute to further analysis of the data.

If the transfer of responsibility for the Study were to be effected, affiliation of qualified university personnel in the conduct of the Study would be desirable. This university participation might involve the associated universities and/or others. The need for such participation is twofold. The richness of this data resource warrants its analysis by multiple groups if appropriate control of this activity is maintained. Secondly, the performance of analyses as designed by or in conjunction with non-AEC contractor personnel will lend credibility to the objectivity of the results. Specifically, an affiliation with the Harvard University Department of Epidemiology may be desirable for reasons discussed in Enclosure 2. Remarks concerning the transfer of administrative responsibility for the Study are also included in the enclosure.

8. U.S. Transuranium Registry.

Relative to the question of transferring the U.S. Transuranium Registry (USTR), Enclosure 3 contains a brief discussion of the various plutonium studies in man, including the USTR, and makes recommendations concerning the future disposition of those programs.

The following recommendations are made in the enclosure:

a. Assign to the Health and Mortality Study the epidemiologic study of AEC contractor employees with known plutonium deposition.

b. Assign to Dr. L.H. Hempelmann responsibility for the clinical follow-up of separated employees with plutonium burdens. LASL would be the contractor for this program since it would be an extension of a project now conducted by Dr. Hempelmann for LASL.

c. The following options relative to the U.S. Transuranium Registry are offered in order of preference:
   (1) Retain the USTR at Hanford under either HEHF or PNL if a suitable M.D. director can be recruited.
   (2) Transfer it to LASL under the supervision of Dr. Hempelmann if he can be persuaded to retire from the University of Rochester soon and is sufficiently interested in this project.
   (3) Transfer it to ORAU.

d. Retain at LASL and PNL the monitoring of plutonium levels in tissues obtained at autopsy from the general population.

The principal reasons for recommending Hanford or LASL over ORAU as the site for the Registry, provided that a suitable director can be recruited at either location, are as follows:

a. LASL and Hanford are active cooperating organizations in the program and are major plutonium facilities.

b. Hanford is an important source of autopsy material for the Registry, and Los Alamos is likely to become such a source.

c. Both sites have radiochemistry laboratories where human tissue analyses for plutonium are now being conducted.

d. PNL and LASL have ongoing radiobiological plutonium studies that would provide a base for additional scientific exploitation of material that will become available through the Registry.

Summary of Recommendations

The following categories of recommendations are offered:

1. Early implementation by ORAU of (a) an emergency treatment facility for radiation accidents, (b) a training center for occupational physicians in medical problems relating to accidental radiation exposure, and (c) a registry of radiation accident victims;
2. Exploration of the feasibility of developing (a) an occupational radiation exposure registry, (b) a nationwide program of monitoring public health and demographic statistics in areas around nuclear plants, and (c) a health effects assessment program;
3. Assumption of administrative responsibility for the AEC Health and Mortality Study at the end of three years;
4. Assumption of responsibility for the U.S. Transuranium Registry at a future date only if an appropriate director for the Registry cannot be recruited within a reasonable period at Hanford by either HEHF or PNL or at Los Alamos by LASL.

Enclosure 1

Activities Relevant to a Radiation Workers Directory

Mr. Eason's Radiation Exposure Directory consisted principally of (a) individual records of overexposures and (b) statistics summarizing exposure information for contractor and licensee plants. With dissolution of Mr. Eason's unit, the Directory has been split into a contractor segment in the Division of Operational Safety and a licensee segment in the Directorate of Regulation.

The master employment roster now being prepared by Dr. Mancuso is designed to enable the investigator to access quickly all sites of employment for ~~each~~ individual employees. Query of the contractor employers would then permit the investigator to develop a complete cumulative exposure record for employees whose work experience is confined to plants covered in the roster. Although Dr. Mancuso is developing this roster for use in the HMS, i.e., to improve the completeness of the HMS radiation exposure data for employees in the plants under study, the roster could be made available for employer use by incorporating it into a central registry.

The proposal for a Radiation Workers Directory as submitted by Dr. Hart would extend the roster compiled by Dr. Mancuso and serve certain additional functions. In the 189 form submitted by Mr. Hart it is stated that the Directory "would (i) categorically identify persons for whom radiation exposure information was accrued under the auspices of MED and/or the AEC, (ii) locate existing radiation exposure records accrued for such employees, (iii) determine the kind of exposure records on file, (iv) determine the value of such records in reconstructing the radiation history of the employee, and (v) establish procedures for interpreting such records _in futuro_ by qualified experts who had no part in generating the original records."

The HMS now collects radiation exposure data on individual employees. If, as suggested in 7. of the attached report, this program is extended to all other contractors for ongoing data collection, future radiation exposure information could be made immediately available to a registry provided that safeguards to protect the data are built into the system. Past exposure data would remain a difficult and relevant problem with respect to this generation of workers. That problem has been addressed by ~~the group discussed above~~ Dr. Mancuso and Mr. Hart and would become a principal undertaking of the Registry.

Enclosure 2

Status of the Health and Mortality Study

This contract with the University of Pittsburgh has been in existence for ten years. Performance under the contract has been of mixed quality. Transfer of the project to another institution has been considered from time to time during the lifetime of the contract but has been rejected each time. Some of the reasons that have been advanced for and against retention of the contract at the University of Pittsburgh are as follows:

Pro

1. The investigators have conducted the data collection in an exceedingly painstaking and careful manner. The quality of the data has profited from the unusual care expended in this effort. Although the somewhat excessive attention to detail has retarded the progress of the project and impeded publication, it has reduced the likelihood of biased analyses, which, at times, would have been to the detriment of the agency and the industry.
2. The investigators have consistently sought and found legitimate reasons for differences in longevity and mortality between the employee and control populations that have emerged in the analyses. Less careful workers might have accepted and exploited for their personal benefit positive results that were due to a hidden bias.
3. The investigators have developed a method for ascertaining time and place of death based on Social Security Administration records that avoided direct follow-up contact with separated [illegible] families. For such a large project this method is probably more economical than alternative procedures and is more accepta~~nce~~ble to contractors since it avoids follow-up questioning of separated employees.
4. BER personnel responsible for the administration of this contract have feared adverse effects of contract termination at some time other than the completion of a specific phase of the study. The anxiety is motivated by the fear that the investigators might claim that their contract will have been terminated because of AEC anticipation that the investigators were developing unfavorable results. The sensitivity of the health issue in this industry makes an orderly transfer of administration of this project highly desirable.

Con:

1. The only extant publications are annual reports and a special report of a Health Physics Society Symposium in 1972 that had limited cir-

culation. No papers are in preparation at this time. The publication record for this project is dismal.

2. The progress of the study has been unduly slow. Analysis was undertaken unnecessarily late and relationships to radiation exposure were explored only recently under pressure from AEC. That pressure has accelerated progress significantly during the last few years but the need for such pressure does not recommend the investigators.
3. Statistical methodology has been weak. Dr. Robert Elston of the University of North Carolina has provided limited biostatistical support recently in a consultant capacity. If the Harvard University Department of Epidemiology can be involved in the study, analysis of the data will be strengthened.
4. Dr. Mancuso has been unable to establish an effective working relationship between himself and Dr. Sanders on the one hand and the Oak Ridge Computing Technology Center on the other. This deficiency has hampered analysis of the data.

On balance, it will be desirable to phase out this principal investigator as soon as it can be accomplished in an orderly manner. I would recommend setting an arbitrary target date of three years (August 1, 1977) for termination of the contract. That date should coincide with completion of the analysis of Oak Ridge and Mound as well as Hanford data. The possibility of a small clean-up of incomplete projects, subsequent to that date might be offered. AEC willingness to have Dr. Mancuso retained as a consultant as needed by the organization continuing the study would be an appropriate good will gesture. Dr. Mancuso will be 65 years of age in 1977.

The discussion with Dr. Mancuso of future plans for the Study should take place in Headquarters, preferably with Dr. Liverman leading the discussion. It would be desirable to lend maximum authority to the timetable.

A means of bolstering the project may be available for the interim period until 1977. Dr. Mancuso stated in May 1974 that he would welcome statistical and epidemiologic support from the Harvard University Department of Epidemiology. This suggestion followed discussions between Drs. Mancuso and George F. Hutchison of Harvard University in which Dr. Hutchison apparently indicated his interest in working with Dr. Mancuso if this activity could be made part of a graduate training program in radiation epidemiology. Since the Harvard department is an outstanding epidemiology department and

Drs. Hutchison and Brian MacMahon of that department probably the most prestigious radiation epidemiologists in the country, consideration should be given to a contractual arrangement with Dr. Hutchison under which he would provide support to the HMS in a program that would include graduate student participation.

There is much to be said on behalf of such a contract. Dr. Hutchison has become very familiar with the HMS through serving as chairman of an AEC committee that reviewed the HMS program and as a member of a site visit committee that reviewed Dr. Mancuso's NCI grant proposal for the study of disability as an indicator of health status in the HMS population. The second aspect of the program, involving the training of radiation epidemiologists, would meet a pressing need for additional trained personnel in this field. Dr. Hutchison is superbly qualified to sponsor a training program in radiation epidemiology. He is a sound investigator and has had extensive experience in radiation epidemiology. In addition to his contact with the Mancuso study, he is a member of the Advisory Committee of the Center for Human Radiobiology and is chairman of an ad hoc committee that is now reviewing the epidemiologic design of the radium study. He collaborated with Dr. MacMaho in a major epidemiologic study of the relationship of irradiation of the fetus during pregnancy to childhood cancer and leukemia. For several years Dr. Hutchison served as epidemiologist in the radiation therapy department of Michael Reese Hospital in Chicago.

It would be necessary to inform Dr. Hutchison of the planned phase out of the University of Pittsburgh role in the HMS and its potential replacement by ORAU. There is little reason to believe that a working arrangement with the Harvard Department of Epidemiology could not be worked out by ORAU, but no advance assurance of such a continuing relationship could be provided by BER.

If a satisfactory arrangement could not be worked out with Harvard University, the possibility of having another university epidemiology department provide scientific support to Dr. Mancuso at the University of Pittsburgh for the 1974-1977 period should be explored. Dr. Warren Winkelstein, Dean of the School of Public Health of the University of California, has expressed interest in collaborating with LBL staff in AEC sponsored epidemiologic studies and could be a suitable candidate. However, an effective arrangement would require Dr. Mancuso's willing cooperation with the selected group.

ENCLOSURE 3

Plutonium Studies in Man

Four activities are the principal components in the program of investigation of plutonium deposition in man:

1. Epidemiologic study of the health of employees with known plutonium deposition.
2. The study of the health effects of human plutonium deposition in the employee population by follow-up clinical examination of exposed workers.
3. The study of plutonium deposition in the tissues of exposed workers obtained at autopsy (U.S. Transuranium Registry).
4. The study of levels of plutonium deposition in tissues of the general population obtained at autopsy.

Recommendations relative to these activities are as follows:

1. The epidemiologic study can be undertaken most advantageously within the framework of the Health and Mortality Study (HMS) using analytic methodology of that study. The inclusion of future data will be automatic if extension of the collection of ongoing HMS data to all contractor plants is consummated. However, it must be recognized that results of interest will not emerge for many years in plants where past data have not been collected and analyzed. Hanford and Mound Laboratories are the only facilities included now in the HMS where substantial employee exposure to plutonium has occurred. If the analysis of past, as well as future, data for all plutonium exposures were ever considered necessary in order to enlarge the study population, past data would have to be collected on employees with plutonium exposures at Rocky Flats, Los Alamos and Savannah River. Such an extension of the HMS is not contemplated now.

   Primary epidemiologic study of the employee population with plutonium burdens may be accomplished by query of the HMS files for the analysis of this subset of the study population. Thus, the administrative disposition of the study of employees with plutonium burdens would be tied to the disposition of the HMS. If other studies on the data from plutonium workers are proposed by acceptable investigators, access to the data should be permitted for such studies.

2. The program of clinical follow-up of plutonium workers is also an epidemiologic study but reflects a different approach to the problem of monitoring the health of employees in the industry. The HMS analyses are

concerned with mortality although disability is also being used as an indicator of health status by Dr. Mancuso in an NCI grant. The clinical follow-up of plutonium workers discussed here would provide information on disease occurrence and might permit detection of unusual disease incidence before large numbers of deaths in the study population have occurred. The relatively small numbers of significantly exposed employees and the low levels of deposition in the workers make it unlikely that a positive effect can be demonstrated. However, a program of this kind provides reassurance to the public and the Congress that AEC is fulfilling its responsibilities to its workers. Furthermore, negative results, if obtained, may be reassuring relative to the much lower plutonium exposures encountered in the general population.

Clinical follow-up of exposed employees before employee separation is automatic in the occupational health programs of all contractor plants. The principal existing program of health surveillance of separated employees has involved medical follow-up of 25 LASL employees with substantial body burdens. An epidemiologic follow-up of another 250 separated LASL employees is planned and could be considered as a base population for clinical follow-up. A limited follow-up program is contemplated at Hanford.

Organization and coordination of this program and extension to other plants should be undertaken soon. The following program is recommended:

a. Designate a responsible institution and principal investigator;
b. Set a lower limit of deposition to define the study population and seek to include all separated employees within that population;
c. Develop a protocol for the clinical examination and for health physics examinations;
d. Develop a plan for implementing the examination when the separated employee has moved from the immediate neighborhood of the plant, i.e., choose among the alternatives of (a) bringing the former employee back to his own plant for examination, (b) have the clinical examination performed by local personnel at the separated employee's current site of residence or (c) have him travel to the nearest designated center in the program;
e. Estimate cost of the program for the various participating organizations;
f. Arrange for the assumption of costs by the operating divisions; and
g. Seek a mechanism for obtaining the cooperation of facilities which

may be reluctant to participate in the program.

In view of his long association with both the occupational health program at LASL (30 years) and the follow-up of the 25 LASL employees as well as his additional experience in radiation epidemiology studies, Dr. Louis H. Hempelmann of the University of Rochester is the logical person to head up such a study. Dr. Hempelmann has stated that he intends to retire from the University of Rochester soon and take up residence in Los Alamos. Acceleration of his retirement might be discussed with Dr. Hempelmann, but, in the meantime, it may be possible to work out an arrangement with him at the University such that he can assume the status of principal investigator and coordinator of this project in advance of his retirement.

3. The U.S. Transuranium Registry (USTR) originally considered its mission to include both the autopsy program and the epidemiologic follow-up study of workers with plutonium burdens. More recently, the Registry has been asked to concentrate on the autopsy program. The epidemiologic study was considered above in 1. as a separate program.

The autopsy program involves such activities as:

a. soliciting the cooperation of contractors or licensees in participating in the Registry;

b. making arrangements to have employees indicate their willingness to have autopsies performed at the time of their [illegible];

c. maintaining contact with individuals who have provided written consent for late autopsy;

d. providing a protocol to the pathologist performing the autopsy upon notification of death and making arrangements for transfer of tissues to PNL for radioanalysis;

e. providing payment for cooperation of next of kin in accordance with a contractual arrangement concluded earlier with the deceased;

f. analysis of data, including correlation of autopsy with in vivo health physics measurements;

g. publication of results; and

h. coordinating with a cooperating radiobiological laboratory to have additional studies of interest performed on autopsy tissues obtained by the Registry.

The recent resignation of Dr. Norcross as director of the USTR has left the Registry without permanent leadership despite Dr. Norwood's appointment as acting director. The current vacancy in the directorship of the USTR makes this a proper time to consider any transfer of the Registry from the Hanford Environmental Health Foundation (HEHF), the present contractor. However, if a decision to transfer were to be made, it should be done in advance of the hiring of a new director by HEHF; they are actively recruiting now.

The following options relative to the future of the USTR may be considered:

a. Continue the program at Hanford.

If this were done with HEHF continuing as contractor, it would be necessary to find an acceptable permanent director. I would favor setting a time limit on that recruitment effort. An alternative would be to keep the program at Hanford and transfer responsibility for the contract to PNL. Dr. Alpen and members of the Battelle staff have expressed considerable interest in assuming responsibility for the Registry and in correlating that activity with their animal plutonium work. If transfer to PNL were contemplated, I feel that it would be necessary to have PNL recruit a physician to serve as the principal investigator or a major participant. A decision to transfer could not be made unless PNL could provide assurance of the success of that recruitment.

Advantages:

(1) A prime consideration in choosing a USTR contractor is to have him provide the type of leadership required to enlist contractors in the program and communicate to them the enthusiasm required to recruit employees into the Registry. This requires considerable evangelical zeal which in turn demands an interest and belief in the importance of the project. HEHF started the Registry and has continued to display this enthusiasm. The part-time deputy director of the Registry is a PNL health physicist. The long-term success of the program would require a dedicated effort by any alternative organization that were chosen.

(2) A second consideration is the in-group status of the contractor. Hanford, LASL and Rocky Flats have been the active sites in the Registry with Hanford and Rocky Flats contributing the bulk of the autopsies. Hanford seems to enjoy the confidence of the two other organizations. Incidentally, Rocky Flats has provided the largest number of autopsies but is ruled out as contractor for the USTR by a complete absence of radiobiological

expertise and the lack of both leadership and interest. LASL is a credible choice and will be considered below.

(3) Both autopsies and radiochemical analysis are immediately available at Hanford.

(4) A PNL biostatistician, Dr. R. Buschbom, is actively involved in the project at the present time and may be expected to bolster the analysis of results.

(5) The PNL staff is actively cooperating with HEHF in the project and can be expected to round out the program by conducting cooperative radiobiological studies on Registry material.

Disadvantages:

(1) Finding an effective leader is an absolute requirement for continuation of the program at Hanford. Dr. Norcross was a weak leader; Dr. Norwood is a strong director but is too rigid and is now too old. The program cannot be expected to progress favorably unless a suitable director, preferably an M.D., can be recruited.

b. Move the Project to LASL.

Advantages:

(1) LASL [illegible] institution in [illegible] with excellent plutonium radiochemical and health physics capability.

(2) If Dr. Hempelmann could be induced to retire to LASL soon and were interested in the USTR, he could serve as director for both the Registry and the program of follow-up clinical studies on separated employees with plutonium burdens discussed above.

(3) LASL could provide radiobiological support to the Registry.

Disadvantages:

(1) If Dr. Hempelmann were not available in the near future, LASL would be obliged to recruit a suitable director.

(2) I believe that LASL is not strong in biostatistical support despite having a statistical staff.

c. Move the USTR to ORAU.

Advantages:

(1) If Dr. Lushbaugh were to be placed in charge of this program, he has the necessary background for its administration. He is an excellent radiobiologist as well as physician and has served on

the Advisory Committee of the USTR. However, his interest in the recruitment activities in the program would need to be explored since enthusiasm by the administrator would be required as discussed above. Furthermore, it would be necessary to consider whether we are depending on Dr. Lushbaugh for too many activities in the new ORAU program.

(2) The presence of other human study projects at ORAU would permit pooling of expertise and information.

(3) Biostatistical support may become available through proper staffing.

Disadvantages:

(1) The facility is geographically remote from the actively participating organizations (PNL, Rocky Flats, LASL).

(2) There may be resentment at the removal of the project from the participating organizations to an "outsider" group. Since good cooperation is required to build up the number of cases included in the Registry, its further development would be handicapped if alienation of the administration of the project from the sources of the autopsies were to exist.

(3) ORNL does not have an ongoing radiobiological program ~~in~~ plutonium, although there is a prospect that such a program will be developed in the future.

4. The study of plutonium levels in the general population is conducted at PNL and LASL. This program involves the collection of tissue specimens from autopsies performed in general hospitals in Richland, Los Alamos and various cities distant from nuclear plants. Although some workers are incidentally included, the study is directed primarily to the general population and is, in effect, a human plutonium monitoring program.

The participating laboratories are performing in a satisfactory manner. At this point, I would not recommend any changes in this program although there is room for improvement in the quality of information about the deceased under study and in the geographic breadth of the program. One must recognize that obtaining ample tissue specimens from autopsies conducted in multiple geographic locations is a delicate and difficult task.

Summary

The following recommendations have been presented:

1. Assign to the Health and Mortality Study the epidemiologic study

of AEC contractor employees with known plutonium deposition.

2. Assign to Dr. L.H. Hempelmann responsibility for the clinical follow-up of separated employees with plutonium burdens. LASL would be the contractor for this program since it would be an extension of a project now conducted by Dr. Hempelmann for LASL.
3. The following options relative to the U.S. Transuranium Registry are offered in order of preference:
   a. Retain the USTR at Hanford under either HEHF or PNL if a suitable M.D. director can be recruited.
   b. Transfer the USTR to LASL under the supervision of Dr. Hempelmann if he can be persuaded to retire from the University of Rochester soon and is sufficiently interested in this project.
   c. Transfer the USTR to ORAU.
4. Retain at LASL and PNL the monitoring of plutonium levels in tissues obtained at autopsy from the general population.

Mr. Rogers. But, didn't you say that the peer review was made in 1972?

Dr. Marks. Yes.

Mr. Rogers. Why did you not take action then before 1974?

Dr. Marks. The importance of the study was such that there was a feeling that action should not be taken precipitously.

Mr. Rogers. But, is that not what peer reviews are for? If the reviewers say it is no good, why would you wait 2 or three years to terminate?

Dr. Marks. Perhaps we were delinquent in not terminating the study earlier.

Mr. Rogers. Is that what your peer reviewers said? Did the majority of the peer review group say it should be terminated?

Dr. Marks. I would have to refer to my memos at that time.

Mr. Rogers. You may. While you are doing that——

Dr. Marks. I am having trouble finding them.

Mr. Rogers. Go ahead and look for it, and I will ask some other questions. When you are ready, let me know, and I will get back to this.

Dr. Marks. Yes; sir.

Mr. Rogers. When were you first advised by peer reviewers that this study was questionable [indicating Dr. Liverman].

Dr. Liverman. I would be very hard put to come up with a specific date.

Mr. Rogers. I am sure you must have done it for the Inspector General.

Dr. Liverman. We provided the Inspector General with all existing files. I have not read those files. There are some 29 volumes of them.

Mr. Rogers. I presume the critical points you would have studied somewhat. Did you have any discussions with the Inspector General?

Dr. Liverman. Let me give you my recollection.

Mr. ROGERS. Wait. Answer my questions, please, sir.

Dr. LIVERMAN. Yes. I had a discussion with the Inspector General.

Mr. ROGERS. All right, you have had discussions. Did he go into this with you?

Dr. LIVERMAN. He did not ask me, as I recall, the specific date when I first became aware. I certainly do not recall that question.

Mr. ROGERS. Well, can you tell us now when you became aware that there was criticism from a peer review group?

Dr. LIVERMAN. I became aware that there was criticism certainly by the summer of 1974.

Mr. ROGERS. At what time?

Dr. LIVERMAN. Certainly by the summer of 1974, I was aware that there was peer review criticism.

Mr. ROGERS. Who made you aware of that?

Dr. LIVERMAN. I would presume it would have been Dr. Marks, Dr. Weyzen, or one of the people in direct management of that division.

Mr. ROGERS. Was it you, Dr. Weyzen?

Dr. WEYZEN. Sir, I do not recall.

Mr. ROGERS. You don't recall, but was it too bad, then?

Dr. WEYZEN. I do not know whether I told Dr. Liverman of it.

Mr. ROGERS. Were you aware of it?

Dr. WEYZEN. Yes, I was.

Mr. ROGERS. What action did you take? Were you responsible then?

Dr. WEYZEN. No, I was not.

Mr. ROGERS. So you did not have to make a judgment?

Dr. WEYZEN. That is correct, but I did make a judgment.

Mr. ROGERS. But what sort of judgment?

Dr. WEYZEN. In the files that have been handed over to the committee, you will see that in the summer of 1971 or 1972, there are several memos that pointed out the deficiencies as presented by the reviewers.

Mr. ROGERS. I think Dr. Carter has a question.

Mr. CARTER. Was Dr. Mancuso given copies of these reviews?

Dr. LIVERMAN. I would have to rely upon the staff to answer that question specifically, but, in general, unless the investigator asks specifically for the detailed comments of the reviewer, we only provide to him the summary criticisms, and in this specific case I do not know. Dr. Marks, perhaps, knows the answer. I do not know.

Mr. CARTER. Did you [indicating Dr. Mancuso] receive a copy of these reviews in 1974?

Dr. MANCUSO. I never saw any copies of these reviews in 1971, 1972, or 1974 that they are referring to. The first thing I ever saw was a review of January 8, 1976, which I saw in 1977.

Mr. CARTER. So you really did not know about it until 1976?

Dr. MANCUSO. Those reviews were never presented to me nor any criticism.

Mr. CARTER. Thank you.

Dr. LIVERMAN. I have a slight disagreement on that particular point. In early 1972, before I was a part of the agency, there was an exchange between the, then, Director of the Division and the Commission itself, the five Atomic Energy Commissioners, because they were directly interested in this study and similar studies addressing the low-level effects of radiation.

During that exchange, a memorandum was sent from, the then, Commissioner Rainey, to the Director of the Division of Biology and Medicine, saying, we are unhappy with the progress of this study, and we would like you to take steps to see that the program is accelerated in one way or another. Then, a series of letters among Dr. Totter, Dr. Mancuso, and Dr. Marks and Dr. Mancuso plus a site visit suggested that there needed to be some acceleration, that there was unhappiness at the rate at which things were going, and that either one should accelerate the studies or we would have to look elsewhere for leadership and guidance on the program.

So, it was at least in that general time frame and, again, those who were there could speak to this more effectively than I. The files I have provided, which will offer a complete record of what everyone said and did, suggest that Dr. Mancuso was aware that there was dissatisfaction with the work he was carrying out.

Mr. CARTER. What date was that?

Dr. LIVERMAN. The series of memos date from mid-April to mid-July.

Mr. CARTER. Of what year?

Dr. LIVERMAN. 1972.

Mr. CARTER. Even though you were shown this dissatisfaction at that time, you continued, however, to employ this man and to give him a contract until 1977. Is that not correct? [Pause.] Thank you, Mr. Chairman.

Dr. LIVERMAN. May I answer the question, Mr. Chairman?

Mr. ROGERS. Yes.

Dr. LIVERMAN. The decision was made in 1974 or 1975 that the program would in fact be transferred 26 or 27 months later so that the time frame is not 4 years but 2, during which there were deliberations taking place.

Mr. CARTER. Although it was not good enough in 1974, you would continue it 20-odd months. Is that correct?

Dr. LIVERMAN. The normal procedures which we follow with university professors and investigators is not to terminate them abruptly because they have on their payrolls graduate students and other staff, so an orderly phaseout is the normal procedure we follow.

Mr. CARTER. Had Dr. Mancuso really been given a sort of hint that something might happen to him by this reference to his possible retirement at age 62? Was that really in the nature of a hint?

Dr. LIVERMAN. There was no indication he was going to retire at age 62.

Mr. CARTER. That statement was written down in a letter I believe.

Dr. LIVERMAN. Not that he would retire at age 72.

Mr. CARTER. Sixty-two.

Dr. LIVERMAN. Sixty-two, pardon me. The time for the termination of the program would concur with the time at which he would reach 65, and I believe—and Dr. Marks could answer this better than I, that was one of the reasons for allowing the program to continue.

Mr. **Carter**. Wouldn't that have been an early retirement at 62? You refer to it in the letter, I believe, as an early retirement.

Dr. **Liverman**. I did not look into the policies of the university at that time. I relied on my staff, but normal retirement policy without additional sources of income, is 65 in most universities.

Mr. **Carter**. I don't believe you have or anyone has adequately explained why this mention of early retirement was included in the letter.

Mr. Chairman, I yield back.

Mr. **Walgren**. If the gentlemen would yield, we are talking about peer reviews, not letters between Dr. Marks or any other individual official in the hierarchy of ERDA. Dr. Mancuso addressed the question of peer reviews, receiving the opportunity to comment on peer reviews, and as I understand his testimony, there was never any peer review presented to him as adverse.

Dr. **Liverman**. You are correct in that regard. I believe Dr. Mancuso's statement was, he never received a peer review. What I was trying to do was give a little bit of history to say that he had been alerted in 1972 that all was not peace and quiet. Dr. Marks is in a far better position to speak to the peer review question because the project officer handles the peer reviews and is, therefore, aware of any communications between himself and the principal investigator regarding peer reviews. I cannot answer that question myself, specifically. Perhaps Dr. Marks can deal with it.

Dr. **Marks**. May I answer that question?

Mr. **Rogers**. Yes.

Dr. **Marks**. I did communicate the results of that peer review to Dr. Mancuso.

Mr. **Rogers**. In 1972?

Dr. **Marks**. In 1972 or 1973 to him, verbally when we had the results in hand. I asked him if he wanted written confirmation and he said he did not.

Mr. **Rogers**. What was the majority opinion?

Dr. **Marks**. May I read a few pertinent excerpts from this memo? I organized the material by paragraph. Paragraph 3 was titled "Progress of the Study." Three out of five reviewers deplored lack of progress commensurate with the duration of the study.

Mr. **Rogers**. What date is that?

Dr. **Marks**. This memo is dated February 27, 1973. It is a draft document.

Mr. **Rogers**. Is this kind of a summary?

Dr. **Marks**. Yes.

Mr. **Rogers**. Do you have any letters or written statements from the reviewers?

Dr. **Marks**. Yes. They should be in the hands of the committee, to the best of my knowledge, with names blank, I believe. May I go on?

Mr. **Rogers**. Certainly.

Dr. **Marks**. They criticized excessive preoccupation of the investigators with details and unavoidable deficiencies in the data.

Mr. **Rogers**. Unavoidable deficiencies?

Dr. **Marks**. Three reviewers criticized excessive preoccupation of the investigators with details and unavoidable deficiencies in the data. The other two reviewers did not address themselves to this issue. This was a summary of their findings. On publication, four reviewers criticized the publication record of the investigators. One recommended editorial assistance to improve the quality of writing exhibited in the reports of the contractor. Two stated that methodological articles could have been published already. A fifth ignored this aspect of the review.

Mr. ROGERS. So publication was a concern, and yet we have a letter saying they did not think publication was appropriate that early, and I believe that letter was from you, Dr. Weyzen.

Dr. WEYZEN. No, Mr. Chairman, I think there is a slight mixup. The publications referred to here deal with the analyses that were conducted by Dr. Mancuso up to, I believe, 1974, which are the longevity of the workers of Hanford, not their causes of death. The latent periods referred to in my letter deal with the occurrence of cancers in irradiated populations which do not occur until latent periods of as long as 20 years. Two different issues are being discussed.

Mr. ROGERS. That is what Mr. Walgren brought out. He simply didn't have a lot of the information you wanted him to publish on. Now, the only thing I have seen that they asked him to publish on is methodology. Is that right, Dr. Marks?

Dr. MARKS. No, sir.

Mr. ROGERS. What else? That was the main point, as I understood it.

Dr. MARKS. I think it was stated that methodological articles could have been published already by two reviews and four criticized the publication record.

Mr. ROGERS. As I say, there was criticism of the publication record because of not publishing on methodology, and some criticized him because he got detailed and didn't have some of the information. Now, let me read to you exactly what you received on November 30, 1972, not the summary, but what came to you from the reviewers.

> It was the consensus of the group that this was a highly desirable research activity, and deserved continued support. We also agree that the University of Pittsburgh should continue as the contractor.

Now, do you mean that is the basis of the change in contractors, Dr. Liverman?

Dr. LIVERMAN. That review, sir, I have not read.

Mr. ROGERS. It is in your records. You furnished it to us. This is your office, is it not, Dr. Liverman?

Dr. LIVERMAN. Yes, sir. It is an office of 300 people.

Mr. ROGERS. I presume you have given some attention to this case, particularly when you deviate from normal program management procedures, to yank out an investigator in the midst of his investigation, and give his project to someone else. This is a little unusual in the scientific community. We do not have it happen very much in the other agencies, and we support some $2 billion of research in NIH. It especially doesn't happen when the reviewers say it should be continued and the contractor should be the one to continue it.

Dr. LIVERMAN. I have no defense except in my own particular case which may be no defense to you. That is, I rely upon my staff to bring me the considered judgments. That particular report I have not read personally.

Mr. **Rogers**. Are you telling me that your staff did not give you the information they got from the reviewers correctly?

Dr. **Liverman**. I am saying in the December 1974 memo, which served as the basis for the final judgment, that that particular thing was not flagged to my attention.

Mr. **Rogers**. Yet you used this as a basis of getting rid of Mancuso, and the information to the committee in your statement was that the peer reviewers were unfavorable.

All right, Dr. Marks, let's settle down on this now, and let's find out the truth of the matter.

Dr. **Marks**. Of course. Item No. 7 was "General Attitudes of the Reviewers." The tenor of one reviewer's letter was quite strongly favorable to the contractor and his team. Two reviewers were virtually noncommittal.

Mr. **Rogers**. Now, this is your interpretation of what they said. I am giving you what the reviewer did, not my interpretation nor your interpretation.

Dr. **Marks**. I am in agreement that that particular review is quite strongly favorable.

Mr. **Rogers**. It says it was a consensus. It was the consensus. Now, does that mean that the others agreed or did not agree? I understood that a consensus meant that most of them had agreed that it should continue. That was in 1972.

Dr. **Marks**. I believe that two letters were quite critical of that study. If I may continue——

Mr. **Rogers**. Well, you skipped over the first part of your summary, where it says, "four reviewers enthusiastically recommended continuation of the study."

Dr. **Marks**. Yes, sir.

Mr. **Rogers**. Why didn't you read me that instead of jumping to a criticism? That is the first part of your summary, but you seem to have skipped that.

Dr. **Marks**. Well, in a sense, that was directed to the question of whether such a study should be done or not, and was not concerned with the——

Mr. **Rogers**. Well, it looks like this to me, Dr. Liverman. First of all, you give retirement as the excuse, and now you say that was wrong. That is not what was meant. You never provided the doctor with his peer reviews so he could answer criticisms. Now you are claiming that the peer reviews were all negative, and they are not at all. The consensus was positive.

When did yo leave ERDA, Dr. Marks?

Dr. **Marks**. I left in June 1976.

Mr. **Rogers**. When were you hired by Battelle?

Dr. **Marks**. June 1976.

Mr. **Rogers**. Are you now doing part of the work that was originally covered in this contract in your organization?

Dr. **Marks**. I am assisting Dr. Gilbert. She is the principal investigator.

Mr. **Rogers**. Is it under your supervision?

Dr. **Marks**. Only in the sense that all environmental health and safety work is under the supervision of——

Mr. **Rogers**. That is all I am asking. Is it under your office, as I understand it, in Battelle?

Dr. **Marks**. Yes; it is.

Mr. **Rogers**. Now, what is the extent of the contract?

Dr. **Marks**. The extent? It is $100,000 for fiscal year 1978.

Mr. **Rogers**. What is the total contractual work with Battelle to the Department of Energy?

Dr. **Marks**. It is, I believe in the neighborhood of $60 million.

Mr. **Rogers**. Has Battelle ever done a human epidemiological study? before?

Dr. **Marks**. Battelle has cooperated.

Mr. **Rogers**. I didn't ask that. I know they have done animal studies. Is it not a fact that Battelle has never on its own done an epidemiological human health effects study?

Dr. **Marks**. Battelle is not conducting this study per se. It is cooperating with the Hanford Environmental Health Foundation.

Mr. **Rogers**. I understand all of that, but Battelle never has done such a study, has it? Is that not true?

Dr. **Marks**. Battelle has never undertaken a total epidemiological study.

Mr. **Rogers**. Exactly. Now, why, Dr. Liverman, would you have this company assume that responsibility when they have never done human epidemiological studies?

Dr. **Liverman**. May I answer?

Mr. **Rogers**. You certainly may.

Dr. **Liverman**. When Dr. Milham's results were first reported in 1974, I believe that is the time frame, I was concerned that, if his results were true, that is, confirmed by suitable statistical analysis in the view of the scientific community, then, we, in fact, have on our hands a greater effect of low levels of radiation than had previously been reported.

So, I asked not only the Battelle group but others, the Oak Ridge group and others, to examine the data that Dr. Milham had reported on, and to try to give an independent evaluation, an independent estimate of whether or not they would agree or would not agree. I was not interested in what the results were, as long as there was agreement.

Mr. **Rogers**. Then why did you terminate it if you were not interested in the results, if it was an independent study, and turn it over to this group, which is in-house, in effect? Why did you terminate an independent study when the reviewers said the consensus was that it should have been continued?

Dr. **Liverman**. The material provided me concerning the peer review and the basis for my decision was that the peer reviews were, by and large, negative.

Mr. **Rogers**. That simply is not true, even in the summary given to us by Mr. Marks.

Dr. **Liverman**. In the memo dated December something, 1974, which is the basis for my decision——

Mr. **Rogers**. Do we have that?

Dr. **Liverman**. It was not in there [indicating].

Mr. **Rogers**. What are the papers there [indicating] that you did not furnish the committee, sir?

Dr. LIVERMAN. I have several series of notes here, but I do not have those.

Mr. ROGERS. I thought you said that was some papers you did not furnish the committee, and I wondered why.

Dr. LIVERMAN. This [indicating] is 1972.

Mr. ROGERS. I am saying you told me those were not furnished to the committee. Why?

Dr. LIVERMAN. The committee did not request them.

Mr. ROGERS. We requested all of the records pertaining to this, and you have given us two boxes of them.

Dr. LIVERMAN. Per agreement with Dr. Zimmerman of your staff, we provided the material from 1973 forward. I have selected materials from 1972 here. But the rest of the material before 1973, back to 1964, are in another 20 volumes. If the committee would find them useful, we will provide them whenever you desire them.

Mr. ROGERS. We may find it necessary.

Let me ask you, was there competitive bidding for the contract which transferred the study to Battelle?

Dr. LIVERMAN. Was there?

[Dr. Weyzen nods negatively.]

Mr. ROGERS. Who made the judgment to let Battelle have the contract, Was that Dr. Weyzen?

Dr. WEYZEN. Yes, sir.

Mr. ROGERS. You made that judgment?

Dr. WEYZEN. I made that judgment 3 months ago, that the responsibility for the analyses of the Hanford data should be at the Hanford Environmental Health Foundation for a number of practical reasons.

Mr. ROGERS. Had Dr. Marks been your superior?

Dr. WEYZEN. No, sir.

Mr. ROGERS. Had he worked with you?

Dr. WEYZEN. Yes, sir.

Mr. ROGERS. In what capacity?

Dr. WEYZEN. As a colleague.

Mr. ROGERS. In what? Did he have an office?

Dr. WEYZEN. Dr. Marks and I both were on the staff of the medical branch of the division.

Mr. ROGERS. So you have worked together. Were you his superior?

Dr. WEYZEN. No, sir.

Mr. ROGERS. So you were equal workers?

Dr. WEYZEN. Yes, sir.

Mr. ROGERS. Had you worked together on this matter in making a judgment to terminate?

Dr. WEYZEN. I certainly have given Dr. Marks my opinion many times, yes, to terminate the study.

Mr. ROGERS. So the two of you made a judgment to terminate the Mancuso contract?

Dr. WEYZEN. Yes, sir.

Mr. ROGERS. In spite of the peer review?

Dr. WEYZEN. With the peer review, sir.

Mr. ROGERS. In spite of the fact it recommended a continuation?

Dr. WEYZEN. Sir, what you were reading is the perception of one reviewer of what he felt was a consensus.

Mr. **Rogers**. May I say, even your own summary says that the majority approved?

Dr. **Weyzen**. I am not sure which summary——

Mr. **Rogers**. He has just read it [indicating Dr. Marks].

Dr. **Weyzen**. That is not my summary, sir.

Mr. **Rogers**. Well, that is his summary. Did you make up the memo to give to Dr. Liverman?

Dr. **Weyzen**. I do not think so, sir.

Mr. **Rogers**. Who made up the summary?

Dr. **Marks**. I did.

Mr. **Rogers**. And you advised him that the reviewers had recommended changing?

Dr. **Marks**. I don't have that memo with me. I am sorry, Representative Rogers.

Mr. **Rogers**. Excuse me?

Dr. **Marks**. I am sorry, I do not have that memo with me. It would be in the files.

Mr. **Rogers**. Who has the memo?

Dr. **Marks**. It was a memo dated, I believe, December 2, 1974.

Dr. **Liverman**. The memo is in the files.

Mr. **Rogers**. Do we have it?

Dr. **Liverman**. Yes, sir.

Mr. **Rogers**. What date is that?

Dr. **Liverman**. December 1974.

Dr. **Marks**. Probably December 2.

Mr. **Rogers**. We will try to find it. The memo recommends, I understand, orderly disengagement, although your reviewers, as you say right here, four enthusiastically recommended——

Dr. **Liverman**. I believe that, as you mentioned, was a 1972 memorandum.

Mr. **Rogers**. Which was the basis for termination, as I understand it.

Dr. **Liverman**. There were many other bases, and there were many peer reviews.

Mr. **Rogers**. There were no additonal reviews before the judgment was made. Is that not true? You told me before it was based on the peer review of 1972. That is what you told me [indicating Dr. Weyzen].

Dr. **Weyzen**. Sir, there should be one point made clear. Four reviewers in 1972 recommended continuation of the study, but they did not address themselves to the fact of who should conduct the study.

Mr. **Rogers**. No? He said it was the consensus that it should still be the university——

Dr. **Liverman**. I don't think——

Mr. **Rogers**. "We also agreed," this reviewer wrote "that the University of Pittsburgh should continue as the contractor." Someone has been giving someone else information. Somebody has been changing jobs, and contracts are being shifted here. It doesn't look very good, Dr. Liverman, I must say.

Dr. **Liverman**. I can certainly say this group reads it that way. I think it is important, Congressman, to look at all the individual reviews, not the summation of one particular reviewer.

Mr. **Rogers**. That is what I was reading from, the reviewer who was there and reporting on what the consensus of the group was.

Dr. **Liverman**. But I understand——

Mr. **Rogers**. Not a judgment made later of what might have happened, but even there it says that four enthusiastically approved continuation.

Mr. **Carter**. Mr. Chairman?

Mr. **Rogers**. Dr. Carter.

Mr. **Carter**. Thank you, Mr. Chairman.

Dr. Marks, when did you leave AEC?

Dr. **Marks**. It was ERDA at that time. In June of 1976.

Mr. **Carter**. In June of 1976?

Dr. **Marks**. Yes.

Mr. **Carter**. Did you go to work immediately for Battelle?

Dr. **Marks**. Yes, sir.

Mr. **Carter**. When was this contract given to Battelle?

Dr. **Marks**. The study at Battelle was initiated in relation to Dr. Milham's study in the spring——

Mr. **Carter**. I mean this last contract of which Battelle received part.

Dr. **Marks**. This was October 1, 1977, but not to Battelle but to the Hanford Environmental Health Foundation.

Mr. **Carter**. October 1977. Now, when was this first discussed and negotiated?

Dr. **Marks**. The study was not a distinct project at that time, in October of 1977. It was a continuation of analyses that Dr. Gilbert had already been doing since the spring of 1975, so it was not developed as a distinct new project in 1977.

Mr. **Carter**. It was not part of the Mancuso study; it was part of Dr. Gilbert's study.

Dr. **Marks**. It was Dr. Gilbert's study, yes.

Mr. **Carter**. You had gone to Battelle in 1976?

Dr. **Marks**. Yes.

Mr. **Carter**. When were the negotiations first started with Battelle to take over this Gilbert contract? Could you tell me, Doctor?

Dr. **Weyzen**. There were several discussions with all——

Mr. **Rogers**. When? What is the date?

Dr. **Weyzen**. In the past year, I would say. I would have to go from my knowledge.

Mr. **Carter**. In the past year?

Dr. **Weyzen**. In the past year. There were a number of discussions with all participants in the health and mortality study, including people who were collecting data at Hanford, the Mound Laboratory, et cetera, to inform me how the study was organized. About 3 months ago I made the decision and recommended to Dr. Liverman that he assign the responsibility for the analysis of the Hanford workers to the Hanford Environmental Health Foundation.

Mr. **Carter**. It was done by competitive bidding, I am sure, wasn't it?

Dr. **Weyzen**. We never do this by competitive bidding.

Mr. **Carter**. Do you use the buddy system?

Dr. **Weyzen**. Sir, I resent that comment.

Mr. **Walgren.** If the gentleman would yield, Battelle does approximately $60 million worth of business with ERDA?

Dr. **Marks.** That is a guess on my part.

Mr. **Walgren.** Could you just guess how much of that $60 million is in the health evaluation field and how much of that is in the nuclear fuel cycle or other related nuclear research?

Dr. **Marks.** I think about $18 million is in the health, environmental, and safety areas.

Mr. **Walgren.** So $42 million by this laboratory that this part of the project was turned over to does $42 million worth of business with the Federal Government in research other than health on nuclear development?

Dr. **Liverman.** I think in fairness to Dr. Marks we really should provide that for the record, but I would say that it is not that heavily nuclear. It has work going on in the solar and geothermal area, quite a bit in the fossil energy area, so I think it is an incorrect conclusion to say that $40 million of the $60 million is in the nuclear area.

[The following figures were received for the record:]

Fiscal year 1977 operation No. 14—Sept. 16, 1977

	In thousands
Fossil	$844
Solar	5,022
Geothermal	2,484
Magnetic fusion	1,087
Basic energy sciences	3,240
Conservation	1,257
Total	13,934
Nuclear breeder	559
Nuclear research and application	1,782
Fuel cycle	21,035
Special materials production	385
Total	23,761
National security	3,085
Environment and safety	
Biomed and environmental	14,711
Environmental conservation technology	2,833
Operational safety	177
Total environment and Safety	17,721
Total Operation No. 14	58,501

Mr. **Walgren.** Let's put it this way. Battelle has a substantial number of employees that are essentially employed in the nuclear industry, and therefore subject to low-level——

Dr. **Liverman.** Yes, that part is correct.

Mr. **Walgren** [continuing]. Subject to low-level ionizing radiation.

Dr. **Liverman.** They may be. Not all are.

Mr. **Walgren.** So what apparently was done in this case was, after Dr. Milham's study came out indicating that there were dangers that had not been—that did not fit the party line of the nuclear industry, the Department of Energy took the study that was designed to deal with that. There is evidence of more than one approach to Dr. Mancuso to make statements that would negate the Milham findings, and after that, the Department then takes the contract and gives it to a nuclear industry contractor.

Now, you have got to understand that the public does not trust that one iota, and as far as I am concerned, that is a total waste of the research dollar, because those findings are worthless.

Mr. ROGERS. Yes, I am very much concerned, too, I must say. Dr. Liverman, have you ever had Dr. Gilbert's work reviewed?

Dr. LIVERMAN. May I look at this document?

Mr. ROGERS. Answer my question first.

Dr. LIVERMAN. I would have to turn to my staff. I have not had her work reviewed.

Dr. WEYZEN. I have not.

Mr. ROGERS. You did not order a review of that?

Dr. WEYZEN. I know of her work. It has not been reviewed yet.

Dr. LIVERMAN. It was just finished.

Dr. WEYZEN. Yes, this part was just completed.

Mr. ROGERS. Did you have any interim reports like you wanted to do, and review it in the interim? Did you have a peer review of it?

Dr. WEYZEN. No, sir.

Mr. ROGERS. Why not?

Dr. WEYZEN. It will be peer reviewed.

Mr. ROGERS. Didn't you peer review it before you started? Don't you come in with a protocol and decide on the basis of a judgment of peers whether or not this is a good project to do? Do you make that judgment without the advice of a peer group?

Dr. WEYZEN. No, sir, we do not.

Mr. ROGERS. I am not sure I understand you.

Dr. WEYZEN. Every single project is reviewed by peers in time.

Mr. ROGERS. But Dr. Gilbert has not been?

Dr. WEYZEN. This is one of the projects that has not yet been reviewed.

Mr. ROGERS. That is very strange.

Dr. WEYZEN. There are many hundreds which have not been reviewed in a particular year.

Mr. ROGERS. Dr. Hutchison, have you reviewed the Gilbert study?

Dr. HUTCHISON. No, sir, I have not.

Mr. ROGERS. Have you reviewed the Milham study?

Dr. HUTCHISON. You are speaking of an official review by a body as opposed to, have I read this paper?

Mr. ROGERS. Are you aware of them?

Dr. HUTCHISON. I am aware of both of them.

Mr. ROGERS. Have you studied them enough to give a peer review?

Dr. HUTCHISON. No.

Mr. ROGERS. Nor have you been asked to. Is that right?

Dr. HUTCHISON. I have not been asked to review either of them.

Mr. ROGERS. Yes, Dr. Carter.

Mr. CARTER. I would just like to ask one question. Since we have Dr. Stewart here, who has an international reputation, and I believe very much in her work, I would like to ask if you found fault with the Mancuso studies or not?

Dr. STEWART. No. By the time we came there, we found the terms intact. I would like to say that I don't think one minute of time had been wasted in collecting some valuable data. It is unique data, and I think it is true that there have not been. It is obviously true there have not been many publications, but I would regard that as a proper conservative view, though I do agree that there is usually a clash between people who do not want to put these publications out because of the uncertainty and the people who have given the money and wish to have something to show for it.

So, I understand a part of this trouble, but with regard to an independent scientific review, I am quite sure that the right thing was done.

Mr. ROGERS. Mr. Inspector General Seltzer, sir, have you completed your investigation?

Dr. SELTZER. It is being written right now, and it should be completed in 3 or 4 weeks. It is being drafted at this very moment. Our staff people finished their investigative work on Friday last, having gone through some 6,000 documents, and I think that is a conservative estimate, Mr. Chairman. Additionally, they interviewed 27 people, as I recall, and I believe the total amount of effort thus far has been something resembling 100 man-days.

Mr. ROGERS. Have you learned anything new from the testimony today?

Dr. SELTZER. I have learned enough today, sir, to make sure that I put my staff through the paces and that they come up with an accurate, precise report of our investigation.

Mr. ROGERS. We plan to go into that in great detail.

Dr. SELTZER. I understand that.

Mr. ROGERS. So, I would hope you would——

Dr. SELTZER. Indeed, our reputation is at stake, and I am mindful of that.

Mr. ROGERS. Could we have a copy of the draft as soon as it is available?

Dr. SELTZER. As soon as the report is available, I will be more than happy to make it available to you. May I ask, please, if you do not mind, because we do this as a pro forma, to send a letter requesting the draft to the Secretary?

Mr. ROGERS. We will call him.

Dr. SELTZER. All right, sir.

[The information requested was not supplied by the department at the time of printing.]

Mr. ROGERS. Dr. Radford has to take a plane. I am going to ask this panel if you would cooperate with the committee and step aside at this time, and we will ask you to return tomorrow at 10 a.m. and go into further matters at that time.

Dr. LIVERMAN. The same panel that is here, sir?

Mr. ROGERS. Yes, that would be fine, and Dr. Marks, if you could join us, it would be helpful.

Dr. SELTZER. Mr. Chairman, do you want me present as well?

Mr. ROGERS. It may be well for you to be here if you can. I just think we may develop some information it might be well for you to be aware of.

Dr. SELTZER. Very well, sir.

Dr. HUTCHISON. It will be very difficult for me, Mr. Chairman, to be here tomorrow.

Mr. ROGERS. I will hear from Dr. Radford now, if we can.

Dr. LIVERMAN. Mr. Chairman——

Dr. HUTCHISON. Mr. Chairman, I just said it will be very difficult for me to be here tomorrow.

Mr. ROGERS. All right. If you don't mind stepping aside, we will see if we can get to you tonight.

[Dr. Hutchison nods affirmatively.]

Mr. ROGERS. We will try to get to you and finish questioning you.

Dr. LIVERMAN. Thank you, Mr. Chairman.

Mr. ROGERS. Thank you so much for your presence.

Our next witness is Dr. Edward Radford, who is chairman of the BEIR Committee National Academy of Sciences, Department of Epidemiology, Graduate School of Public Health, University of Pittsburgh.

We welcome you to the committee. Your statement will be made a part of the record in full, and you may proceed. Thank you for your presence.

STATEMENT OF EDWARD P. RADFORD, M.D., PH. M., PROFESSOR OF ENVIRONMENTAL EPIDEMIOLOGY, GRADUATE SCHOOL OF PUBLIC HEALTH, UNIVERSITY OF PITTSBURGH

Dr. RADFORD. Thank you, Mr. Chairman, members of the committee. I have submitted a written statement. I will not read all of it in detail. I will refer to certain points of it which I think are especially germane. I would like to add to it, because of today's testimony, some of my own personal observations.

Mr. ROGERS. The committee welcomes that.

Dr. RADFORD. My full name is Edward P. Radford. I am an M.D., and I appear here not officially as a representative of the BEIR Committee. BEIR stands for biological effects of ionizing radiation. I want to make it clear that the BEIR Committee is a committee appointed by the National Academy of Sciences. The present committee has been established to review the problems of radiation effects, especially in low doses.

In effect, it is the type of independent review which I believe the chairman of this committee called for, and it is in response to the kinds of questions that are coming up here. The Environmental Protection Agency has contracted with the National Academy of Sciences to do this review.

I was a member of the original BEIR Committee, which was established in 1970 and issued its report in 1972. It is important to note that the establishment of the BEIR Committee arose out of concern among many people that the then existing bodies who were providing information on radiation risks were, for one reason or another, considered unsuitable.

For example, the International Commission on Radiation Protection is an international body, and it may well be that some of the reason it was considered to be unsuitable was that some felt it should be a U.S. group that should be making recommendations to United States regulatory bodies.

I am currently the chairman of the full committee of the Academy and also chairman of its Subcommittee on Somatic Effects, which means effects on individuals themselves, not on their progeny.

I would just like to add a few points to my curriculum vitae which I think perhaps go to some of the issues which have been especially prominent today. For one, in 1975 to 1976 I was on sabbatical leave in the department of Sir Richard Doll, who is the regius professor of medicine at the University of Oxford and certainly one of the outstanding epidemiologists in the world, also a person who has done a great deal of work on the problems of radiation exposure and cancer.

In a different vein, after I finished my medical training and internship, I entered the U.S. Air Force as a medical officer and took flight training. While I was detailed to the Maxwell Air Force Base, I ws detached on duty to go to the radiological health training program at Edgewood Arsenal, one of the existing radiation training groups. I graduated from there and was immediately shipped out to the Pacific as a radiological protection officer for bomb tests.

Three bomb tests were held in 1948, so-called Operation Sandstone. I was a radiological protection officer associated with a B-29 bomber crew, and we flew photographic missions over the bombs at that time.

Mr. ROGERS. Did you have any exposure at that time?

Dr. RADFORD. It would have been impossible for me to know. We were not issued film badges.

Mr. ROGERS. Who ran that operation? The Air Force or the Department of Defense?

Dr. RADFORD. It was a joint project. In other words, it was run by all three services, in effect. That is, the military support was. The Armed Forces Special Weapons Project was at that time the Government agency that organized these bomb tests in the Pacific. I, of course, was issued monitoring equipment in the form of Geiger counters and things of this type, which I had available at the time we were flying our missions, and also at other occasions.

I want to point out something that bears on the testimony of the gentleman who was the first witness today, which is the attitude toward radiation that existed in 1948. It was still by that time far from sure exactly what effects radiation produced. Indeed, the whole question of the cancers that arose in uranium miners in central Europe was still under active discussion, and a very eminent member of, I believe, one of the Government laboratories at that time in the Manhattan Project had written an article not too long before denying that radiation was probably the cause of lung cancer in the uranium miners from the Joachimsthal-Schneeberg area.

Mr. ROGERS. When was that?

Dr. RADFORD. I think the paper appeared in 1944 or 1945. It is a paper by Lorenz.

The point I am making is, there was still a high degree of controversy. The radiation standard which we were under at that time was one-tenth of one rad per day. That was considered an acceptable occupational risk at the time. Indeed, one of our radiological protection group made up a little song to the tune of "Jimmy Cracked Corn" which went: "Give me one-tenth, and I don't care," meaning, if he got one-tenth a day, it was OK, one-tenth of a rad per day, or 36.5 rad per year.

Now, while we were in the Pacific in 1948, the standard was changed to three-tenths of a rad per week. I should point out that the current standard for occupational exposure to the whole body is 5 rems per year. Three-tenths per week would be 15 per year. So, the standard has dropped another three-fold since 1948.

Futhermore, we were based on Kwajalein at the time, and we were assured that there would be no fallout of radioactivity on Kwajalein, but of course there was, and I can recall going around in the rain monitoring tents, latrines, this, that, and the other thing, showing that indeed we could pick up significant gamma fields at that time. We had no accurate total body exposure measurements, and only crude indicators of beta radiation exposure.

I am not saying this to indicate that there was an unusually high exposure at that time, but simply to point out that no great issue was made of this fallout as a health problem. Our instructions were, don't frighten anyone, the exposure is really not that bad.

I want to be clear. I am not indicting the military at this time, because as I say, at that time in 1948, there was not a great concern about radiation exposures.

Now, the relevance of this is that by 1954, not very many years later, the Japanese data were already starting to come in indicating a potential cancer risk from radiation exposure, and yet I am quite convinced that the attitude of the military in 1957, when the tests discussed this morning took place, had not changed very significantly; again, perhaps through no criticism of anyone in particular, just simply the slow penetration of understanding of this kind and, of course, the fact that at that time environmental exposures to practically anything were not considered of any importance.

Now, jumping ahead to my other point, which is that I worked with Sir Richard Doll in 1975–76. I helped with the updating of a very important study which was not mentioned by anyone this morning, namely, the study of patients with a disease called ankylosing spondylitis who were given X-ray therapeutically to the spine. This is one of the major studies that has been followed up one of the longest times, and it was my opportunity to work with Sir Richard Doll in updating this through 1970. That report is being completed and I have had access to the results.

That is a group which originally was 14,000 patients. It is now approximately 7,000, since they have restricted it to certain groups, but it is a very important group in terms of understanding what radiation effects are. That was radiation given in approximately 10 doses, each dose a few days apart, so it is split dose radiation, not a single zap, a rather important distinction when we get into these questions of dose-related effects.

Mr. **Rogers**. What was the level of the dosage?

Dr. **Radford**. Well, that has not completely been worked out. There is a physicist, Professor Ellis, from the University of Leeds, who is doing that very carefully, but the dose to the bone marrow was approximately 320 rads. The dose to the stomach was 130 rads, again a split dose, 13 rads at a time in that case. The dose to the pancreas was 175 rads. The dose was a function of where the organs lay in relation to the spine and pelvis, which was the area being irradiated.

We can make estimates of what other tissues received, for example, the lung, the esophagus, the kidneys, and excess cancers are appearing in all of these organs. There is an important source of information on radiation effects.

Now, I would just like to say that since Dr. Mancuso works two floors below me at the University of Pittsburgh, and Dr. Stewart and Mr. Kneale I learned, were in residence there, I have had occasion to discuss their study at length with them, and to give them the benefit of my opinion.

Furthermore, the Subcommittee on Somatic Effects has had a meeting these past 2 days, and yesterday morning the full subcommittee heard Dr. Mancuso and Dr. Stewart and Mr. Kneale present their data. We had an opportunity to ask questions, so, I am quite thoroughly familiar with their study.

Now, my testimony has been based predominantly on addressing the issue of what the risks are from radiation, and I will simply read my current views, and then perhaps we can bring out some of the questions later.

Mr. ROGERS. Certainly. On what page are you reading?

Dr. RADFORD. The first page of my testimony, at the bottom. Since the 1972 BEIR report, new evidence indicates that the risk of cancer induction is substantially greater than was thought at that time, on the basis of further followup of populations exposed generally to radiation doses of about 100 rad or more. The absolute risk estimate for total cancer incidence or mortality is probably at least twice as great as was estimated in 1972.

In part, this evidence of increased risk arises from extension of studies into older age groups, where cancer risks from radiation exposure are being found to be high. This observation supports the application of the relative risk model for most or all radiogenic cancers; that is, the risk of a particular type of cancer is proportional to the natural cancer risk. For example, as the population ages, as we get older, our natural risk of cancer from whatever causes, and it may be many, many causes, goes up.

Apparently, also, if we have been irradiated in the past, so also does our cancer risk go up somewhat approximately proportional to the natural risk.

The human data obtained from populations exposed to highly ionizing radiation such as alpha particles, and this is referred to in the trade as high LET radiation—LET is linear energy transfer—indicates that cancer induction at low doses is probably greater per unit of physical dose than at high dose. (The clock and watch dial painters who ingested radium-226 and thorium salts in the 1920's and who later developed bone cancer appear to be an exception.) Thus, for this type of exposure, extrapolation of risk from that found at high doses may underestimate the risk somewhat, not by a big factor, but possibly by as much as two or three.

Now, there has been a lot of talk about the question of whether there have been studies done on low-level exposures over long periods of time, and I point to the studies of miners who inhaled radon over their working lifetime at low doses, and some at higher doses. These are now moving into a rather important period. We are finding significant excess down to radiation exposures on the order of a few rads, 5, 10, and 15 rads.

There is a definable risk from these doses, indicative of how much more hazardous alpha radiation is, because when we apply the so-called quality factor to convert it to a rem, these doses become quite significant.

Theoretical considerations and animal studies have indicated that for sparsely ionizing radiation such as X-rays or beta and gamma rays, so-called low LET radiation, the cancer induction per unit physical dose may decrease at low cumulative doses, especially at low radiation dose rates. That is what we are mainly concerned about in this discussion.

In human studies, however, the evidence that such a low-dose effect exists is not strong, and there are several lines of evidence that suggest that for human populations exposure to this type of radiation either at low-dose rates or at low doses gives approximately the same cancer risk as does exposure to higher doses or dose rates. On this point, I agree with the testimony of, I believe, Dr. Hutchinson, in which he said that the Mancuso, Stewart, and Kneale risk estimates are approximately four times as high as would have been expected. I agree. I think in other words if we accept that the excess cancers they find are all radiation induced, they are not wildly out of line with the linear extrapolation from all the other studies.

I might say the number of studies is very large. It is not just the Japanese data by any means. In fact, there are a lot of reasons to suggest that Japanese data are not very typical in certain cases and cannot be directly applied to U.S. populations, but it is fortunate we now have a large body of information on the British, on mining populations, on children irradiated for thymus enlargement, the tinea capitis cases and others. There are a large number of studies we are factoring in, and we are not depending solely on the Japanese data by any means to estimate cancer risks.

The Japanese studies are important. I do not mean to minimize them, but we are not dependent on them.

Thus, the estimate of cancer risk from current evidence by application of the linear no-threshold dose-response relationship remains appropriate, with stronger support for this procedure than in 1972. It is not perfect, and there are still questions remaining, and you will hear more about this as the hearings go on.

The appropriateness of exposure limits for environmental releases of radionuclides depends on what risk is acceptable. You have already heard that if we adopt the linear hypothesis, which I say scientifically is the only one we can at this time, then we are saying that for any people exposed to radiation, there is a small risk. Therefore, it becomes a question of how much risk is acceptable. I think these risks must be expressed as the percent increase of probability of developing cancer after the latent period has run, 10 or 20 years, or for leukemia, 2 years.

Present evidence suggests that for all cancer, the increased risk is about one-half to 1 percent for each rem exposure. As I say, that is about one-fourth the risk that Dr. Stewart would derive from her studies.

Thus, the appropriate annual exposure limit should keep the cumulative risk below some acceptable limit, say, an increased cancer risk of 3 percent from all man-made environmental sources of carcinogens. Now, that is my number. Let me make a very important point here.

The decision to accept a 3-percent risk or a 5-percent risk or a 2-percent risk or any other kind of risk in this situation with asbestos, with lead, or anything else, when we are talking about the environment, is a decision that has to be made by the public representatives. It is not a scientific decision, and indeed, it is wrong to state that it should be the responsibility of the scientific community to decide what the risks should be. All we can do is provide the best evidence we can, to the public at large and its representatives and its duly constituted authorities who have to make these decisions, what the risks are. Then it is up to the public to decide, well, we want nuclear power, we are going to have to accept some risk for it, and this is what the risk we should accept is.

Mr. ROGERS. I think we agree on that. We are trying to determine if there is a threshold and, if there is, at what level. They are telling us now that no threshold exists, but then they say that workers can still be exposed to 5 rem a year.

Dr. RADFORD. I will come to the occupational limits. I am talking about general population environmental exposures, if we assign a portion of this acceptable risk only to radiation. That is, radiation should not get the whole pie. We know we have other environmental carcinogens, some of which are going to be very difficult to eliminate. After all, there may be some from coal, and we have to have coal.

Mr. ROGERS. Coming from Pennsylvania, that is wise.

Dr. RADFORD. If we exclude the effects of medical X-rays, then perhaps one-third of the acceptable risk should be available for radiation, or a 1-percent excess risk of cancer for the general population. That is one interpretation. An annual whole-body dose of 25 millirem per year from environmental exposure would give about 0.8 to 1.5 increased cancer risk, which is approximately the 1 percent I indicated with some degree of uncertainty.

Thus, the 25 millirem per year general environmental exposure, which is the new EPA standard proposed, I believe, is consistent with this view. In other words, I am endorsing EPA's 25 millirem per year annual whole-body exposure rate for the general population.

As it is unlikely that a single individual would get this amount of exposure every year, there is some conservatism in this exposure limit, useful conservatism in my view, because of the high radiogenic cancer susceptibility of older populations.

Thus the current EPA general population exposure limits are reasonable, except possibly for the limit of 75 millirem per year for the thyroid. The thyroid is a highly radiosensitive organ, but if exposure of the gland is by iodine-131, then the actual dose obsorbed by the acinar cells may be well below the dose to the gland as a whole. To regulate iodine-131 exposure therefore an uptake limit may be preferable, rather than to give a special limit of radiation dose to the gland.

Occupational exposure limits are currently set at 5 rem per year whole body and 15 rem or more to various organs. If these limits were reached by a worker every year for 40 years, the total whole-body dose would be 200 rem, and his subsequent cancer risk would be more than 100 percent greater than expected, especially for female workers.

This degree of cancer risk is unacceptable, in my opinion, and I believe the whole body occupational exposure limit should be reduced at least to 500 millirem per year, with careful review of the limits of exposure to individual organs such as the thyroid or bronchial system. This is a matter that is long overdue for change. Thank you.

Mr. ROGERS. Thank you very much, Dr. Radford.

In your National Academy of Sciences group that discussed the Mancuso study, was there a general feeling that it had validity?

Dr. RADFORD. Well, we didn't actually take a poll or anything like that after the meeting, and I would not want to speak for the rest of the committee. I will speak for myself. The technique used by Dr. Stewart is an established technique. It is not a far out, unheard of technique. It is basically what we call a case-control study.

So, first, with regard to the method, it is not an unusual nor inappropriate method. The findings show a very small excess of cancer, and as I heard Dr. Gilbert testify, her analysis suggests that the multiple myeloma and the pancreatic cancers are the ones in excess. This is in accord with other conversations that I have had with Dr. Land of the National Institutes of Health, who I think will be testifying tomorrow, and you can ask him about that.

In other words, those two cancers are possibly excessive in some workers, and apparently it has been confirmed by Dr. Gilbert, so I don't think there is an argument about that. Now, the only question is, how much of the excess can we ascribe to the radiation? My own feeling is that until we can rule out other possible occupational carcinogens, the question about pancreatic cancer is still uncertain. The reason is that pancreatic cancer, while it is induced by radiation in some of these other populations to which I have referred, is not strikingly so. There are many other sites that seem to be more sensitive to cancer induction by radiation, at least of the type that have been received by those people, than cancer of the pancreas.

However, it is possible conceivably that as in the case of myeloma the likelihood of pancreatic cancer might be dose related. That is, the proportion of cancer induced may be a function of how much radiation they get, with some cancers appearing at the lower dose in higher probability than others. There is evidence in the literature that myeloma is one of these. That is, it is more prominent at the lower doses than at the higher doses for reasons we do not yet fully understand.

Therefore, my conclusion is that there appears to be an excess of cancers in these workers, and indeed it is approximately what I would have expected on the basis of the linear dose-response curve. In other words, it is maybe only one-fourth as big as Dr. Stewart thought, but it is still there.

Mr. ROGERS. You think the standard should be lower?

Dr. **Radford**. I believe the standard should be lower, but not on the basis solely of the Mancuso study, rather, on the basis of the totality of studies we already have. Indeed, if you look critically at the BEIR I report, which came out in 1972, I do not believe that even if we took the risk estimates at that time we would conclude that the occupational cancer risks are greater than they should be and the standards should be lowered.

Mr. **Carter**. As I understand it, the present standard is 5 rem per year, which is really 5,000 millirem. I don't know if I read your testimony correctly. Do you recommend a maximum of 25 millirem?

Dr. **Radford**. That is for a nonoccupational group.

Mr. **Carter**. Would 25 millirem be one four-hundredth of the present level?

Dr. **Radford**. One two-hundredth. No, wait a minute, one two-thousandths, isn't it?

Mr. **Carter**. Wait a minute. You divide——

Dr. **Radford**. One four-hundredth. Your arithmetic is better than mine, Representative Carter.

Mr. **Carter**. Thank you. You are recommending one four-hundredth of what we recognize now as the standard. I want to thank you for your testimony. I think it is very good.

Mr. **Rogers**. We may submit some questions for you for the record.

Dr. **Radford**. I do want to make the point that the 25 millirem is the recommended EPA standard for the general public.

Mr. **Rogers**. Not for occupational exposure, however.

Dr. **Radford**. The workers do accept some risk.

Mr. **Rogers**. For them you recommend 500 millrem?

Dr. **Radford**. 500 millirem or thereabouts per year.

Mr. **Rogers**. The committee stands in recess for 2 minutes. Thank you, Dr. Radford.

[Brief recess.]

Mr. **Rogers**. The subcommittee will come to order, please.

Dr. **Hutchison**. Thank you. We will try to conclude quickly. I know it has been a long day, and I appreciate your patience.

Have you reviewed the Mancuso study?

STATEMENT OF GEORGE B. HUTCHISON, M.D., M. PH.—Resumed

Mr. **Rogers**. Have you ever given a recommendation as to whether it should be continued or not?

Dr. **Hutchison**. Yes; I was on one of the review committees.

Mr. **Rogers**. What is your feeling?

Dr. **Hutchison**. My feeling was that the study should be continued with some changes in the method of operation.

Mr. **Rogers**. This is often done in the scientific community where you have a discussion with the investigator, who says, we think certain changes should be made. Did you have the opportunity to discuss this with Dr. Mancuso officially?

Dr. **Hutchison**. Unofficially I did. Dr. Mancuso and I have talked, I think, on several occasions about this study, not, however, as an official representative of any of the review committees.

Mr. **Rogers**. But it was your feeling that it should continue?

Dr. **Hutchison**. Yes, sir.

Mr. ROGERS. Did you give any validity to the Milham study?

Dr. HUTCHISON. Yes; I do give validity to the Milham study. I have not reviewed that with the detail that I have the others.

Mr. ROGERS. Do you differ in your viewpoint from Dr. Radford, who just testified?

Dr. HUTCHISON. I differ quantitatively. I had not heard Dr. Radford express his exact level of 500 millirem as the recommended annual occupational exposure. I was surprised at that low a level. I would not have picked that low a level as my own judgment.

Mr. ROGERS. What would be your judgment?

Dr. HUTCHISON. I have felt that the 5-rem level is reasonable. It is correct that since the 1972 BEIR report, additional evidence has indicated a greater hazard than we had supposed in 1972, and I would not at all argue with someone who recommended some lowering of the permissible level. If you press me to state a figure, I would think perhaps 3 rem in place of the 5. I would be hesitant to speak of going to 0.5 rem, which is 500 millirem.

Mr. ROGERS. Have you seen the study that Dr. Radford was talking about? You may not have, since it has not yet been published, but the results are known.

Dr. HUTCHISON. No; I am not acquainted with the present BEIR report, Mr. Chairman. There have been three BEIR reports. I was on the first BEIR Report Committee that reported in 1972.

Mr. ROGERS. I don't think this was a BEIR report that he referred to. I think it was another study with another investigator.

Dr. HUTCHISON. The ankylosing spondylitis study from Great Britain? I am acquainted with this. Yes; Dr. Radford has been in Great Britain working with Dr. Doll last year or the year before. I am acquainted with his work.

Mr. ROGERS. Would that lend weight to the view of reducing the standard?

Dr. HUTCHISON. I am not acquainted with the current findings Dr. Radford alluded to. The existing standards have very heavily taken into account the earlier ankylosing spondylitis data, and I feel that the standards are in accord with that evidence, and I do not know the new evidence.

Mr. ROGERS. Would it be normal for a scientist, if there was some concern about his work, to have that told to him by the contract officer, in order to help the scientist to correct any deficiencies? Is that a normal practice? I am just thinking of what would be normal in the scientific community.

Dr. HUTCHISON. I understand your question. There has been a change in the normal procedure in recent years. Certainly 5 to 10 years ago it was not common to relate to an investigator the reviews, and I think one could not legally get the reviews at that time, as one can now. If the review is favorable, as Dr. Mancuso spoke, the investigator commonly does not care. If his support continues to come in, he assumes that it was favorable, and he does not want to know what each accolade was. If he does not receive funding, then he does want to know, of course.

Mr. ROGERS. I mean, before they would stop the funding, is it not normal practice to at least have a discussion with the investigator to see if the study could be changed to conform to whatever criticisms there may have been?

Dr. HUTCHISON. It is common, sir, but it is not universal.

Mr. ROGERS. But it is the general practice, I presume.

Dr. HUTCHISON. We would have to attempt to find a probability number, sir; 50 percent of the time I would think that it is done, and 50 percent of the time I would think it is not.

Mr. ROGERS. You mean they just cut them off?

Dr. HUTCHISON. Yes, I think that is correct. The investigator then may ask and normally does ask, and upon asking he can find what the stated reasons are. Those would be the reasons that the funding agency chose to tell him by their own interpretation in previous years. Now he may request through the Freedom of Information Act the exact documents. That is a change in recent years.

Mr. ROGERS. Now, you have served on peer review committees for DOE or ERDA?

Dr. HUTCHISON. Yes, sir. For ERDA, yes.

Mr. ROGERS. In this study, were you ever told by Dr. Weyzen that the implications of the Mancuso report were very serious, and that you really ought to look at that carefully?

Dr. HUTCHISON. I have not been told that by Dr. Weyzen. Dr. Sid Marks and I have talked of that, but I think that was clearly understood at the time of such a review without anyone specifically saying that. These were always considered extremely serious studies.

Mr. ROGERS. What was the concern? Why was it of such great concern that a study would show that there was low-level radiation causing cancer?

Dr. HUTCHISON. The concern, of course, relates to setting permissible standards for occupational exposure and general population exposure by extrapolation.

Mr. ROGERS. So it would have an effect on the way the agency would have to do business?

Dr. HUTCHISON. The way everyone using atomic energy would do business; yes, sir.

Mr. ROGERS. Thank you. Mr. Walgren?

Mr. WALGREN. I have no questions, Mr. Chairman.

Mr. ROGERS. I think I see Dr. Carter. Let me ask him if he has a question, Dr. Hutchison.

Mr. WALGREN. If I might fill in the gap here, I am concerned about the concept of perspective, and I really feel that the witness just previous to you put his finger on something when he said that it took from the early 1950's until 1957, and even then the increased sensitivity had not filtered up in the military to change the treatment or the approach, literally, the perspective on exposure of military personnel, on radiation dangers in connection with atomic bombs.

The same word was used earlier by Dr. Gilbert. Do you have confidence in the perspective of research coming out of a company that is doing multimillions of dollars in the nuclear research and development industry other than health? Would you trust a company of that nature to have an independent perspective on health matters?

Dr. HUTCHISON. I think it is very difficult to trust it. I do, however, think of instances where I have felt satisfied. Such an organization may find an investigator, for example, an investigator in a university, and it may be made perfectly clear that despite that funding, that investigator has been given a free hand to do scientific work and to publish whatever he wants to report in the scientific literature.

If you are speaking of a scientist hired by the company, working as an employee of the company, I would share your worry that it is difficult ever to feel sure that such work has the nature that I just described, the freedom of inquiry nature.

Mr. **Walgren.** It is so important for us to try to avoid the type of gap that Dr. Radford just testified to, and I cannot help but remember the witnesses from the Department of Energy who were here giving testimony just several days ago. When I asked them what their own exposure to radiation personally was, it was something they just dismissed out of hand. They referred to it as, well, no more than I get in the dentist's office, words like that.

It strikes me that they certainly, having been exposed, have a perspective that is influenced by that position that they find themselves in, and wouldn't it seem to you to be certainly far wiser when we are really asking for the public to put its confidence in these findings, that the studies be done by agencies that are really independent of organizations that make a great amount of money and have a vested interest in the present technologies?

Dr. **Hutchison.** There is much to be said for your argument. A particular problem that is real in this regard is that a long-term followup study of huge populations ceases to have very great interest often to the university scientist. It is not often going to produce any valuable publications. Yet this sort of work must be done. The Department of Energy in this instance—and many other instances could be cited—must find someone who is willing to do this sort of routine, perhaps nonimaginative work, and they find difficulty in finding a competent investigator who will do it. I think that is the instance when such a thing must be done within the Department.

Mr. **Walgren.** Do you feel it was difficult to find a competent investigator to carry out this particular project outside of a multimillion dollar corporation?

Dr. **Hutchison.** It has not been up until the present date, since they already had dr. Mancuso doing the work. They did anticipate, I presume, that this work would be carried on for decades in the future. If that is true, Dr. Mancuso presumably would not be following it in decades, and the problem then would be to find——

Mr. **Walgren.** But would not the university or a university be the logical place for this kind of a study, if we are really concerned about the confidence the public puts into the outcome?

Dr. **Hutchison.** If, sir, one could find a university that wanted to take on this sort of routine investigation.

Mr. **Walgren.** Thank you, Mr. Chairman.

Mr. **Rogers.** Dr. Carter?

Mr. **Carter.** Thank you, Mr. Chairman.

In the 1957 atomic blast called "Smoky", there were 2,235 men with badges, and of that number, the records of 447 have been checked by the Center for Disease Control. It is my understanding in consulting the national cancer statistics we find that the expected incidence of leukemia in this age group of 40 to 44 is 4.1 per 100,000. Yet out of the 447 which have been checked, 8 cases of leukemia have been verified. Do you regard this as statistically significant?

Dr. **Hutchison**. The difficulty we have here, sir, are the two figures you mentioned. To begin with, should this be related to the 447 men for whom they have the information, or should it be related to the whole 2,200 who have been exposed? If we can imagine that the 447 are a representative group, let us suppose that someone had taken——

Mr. **Carter**. I don't think that is even necessary. Just relate it to the 2,235.

Dr. **Hutchison**. Oh, if it were related to the 2,235, then the figure that I mentiond before, which turned out to be a twentyfold increase after you corrected my estimate of the expected rate, would be reduced by a factor of 5, so it would be a fourfold increase, and that would again be a significant excess.

Mr. **Carter**. It would be statistically significant?

Dr. **Hutchison**. Yes, sir.

Mr. **Carter**. And would indicate, then, in your opinion, that at this atomic blast, more men have come down with leukemia than would ordinarily be expected, and that the increased incidence is probably due to their exposure to low-level radiation.

Dr. **Hutchison**. Yes. Will you be sure, sir, to keep the word "probably" in your statement, because we have mentioned other possible interpretations, but yes, I agree with you.

Mr. **Carter**. You say it is statistically significant?

Dr. **Hutchison**. Yes, sir, I believe it would be.

Mr. **Carter**. Thank you, sir. Thank you very kindly.

Mr. **Rogers**. Doctor, thank you for your presence here today. The committee may be in touch with you.

It is now 5:45 p.m., and the committee will stand adjourned until 10 a.m. tomorrow morning. The committee is adjourned.

[Whereupon, at 5:45 p.m., the hearing was adjourned, to reconvene at 10 a.m., Thursday, February 9, 1978.]

EFFECTS OF RADIATION ON HUMAN HEALTH

Health Effects of Ionizing Radiation

THURSDAY, FEBRUARY 9, 1978

House of Representatives,
Subcommittee on Health and the Environment,
Committee on Interstate and Foreign Commerce,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10 a.m., in room 2322, Rayburn House Office Building, Hon. Paul G. Rogers, chairman, presiding.

Mr. Rogers. The subcommittee will come to order, please. We are continuing our oversight hearings on low-level ionizing radiation and we will continue with witnesses from the Department of Energy, Dr. Liverman and his associates. Dr. Marks, thank you for joining the group. We also have Dr. Gilbert and Dr. Weyzen. Is the Inspector General here?

Dr. Liverman. Well, I recall that you told him to be here. I presume he will be here shortly. I will have one of my people check, sir.

Mr. Rogers. Thank you. I think you said you wanted to make a comment.

FURTHER STATEMENT OF JAMES L. LIVERMAN, PH. D., ACTING ASSISTANT SECRETARY FOR ENVIRONMENT, DEPARTMENT OF ENERGY, ACCOMPANIED BY WALTER WEYZEN, M.D., PH. D., RADIATION BIOLOGY IMMUNOLOGY, DIVISION OF BIOMEDICAL ENVIRONMENTAL RESEARCH, HUMAN HEALTH STUDIES PROGRAM, DOE; JOSEPH SELTZER, ACTING INSPECTOR GENERAL, DOE; SIDNEY MARKS, M.D., PH. D., BIOSTATISTICS, BATTELLE CORP.; AND ETHEL S. GILBERT, PH. D., BIOSTATISTICS, PACIFIC NORTHWEST LABORATORY

Dr. Liverman. If I might be permitted, yes, I would like to try to summarize very briefly what I believe the committee was trying to address yesterday and where I think we came out at the end of the day.

I think there are basically five questions.

Did I, in making the final decision to terminate Dr. Mancuso's support and transfer the program elsewhere, act responsibly on the basis of the evidence brought before me?

Did my staff act in good faith and use their best judgment in conjunction with the expressed views of the peer reviewers in formulating the recommendations brought to me for decision or was there, as was implied in the line of questioning toward the end of the day, some improper relationship which ultimately resulted in Dr. Marks' accepting employment at Battelle-Pacific Northwest Laboratories in Hanford?

Did the staff of the agency deal in candor and in a proper and appropriate manner with Dr. Mancuso during the administration of his contract and in securing the orderly transition and movement of copies of the records to the new contractor?

Did the Government, by moving the program from Dr. Mancuso's leadership to the Oak Ridge Associated Universities, reduce the credibility of the analyses yet to be done, that is, did the Government by its action set the fox to watch the chickenhouse?

Finally, and a question that really never got addressed in yesterday's hearings, are Dr. Mancuso's conclusions adequately justified on the basis of the statistical methodology he has used to express the relationship between radiation and mortality and is that evidence an adequate basis on which to revise national standards?

May I speak for just a moment to each of those, sir.

With regard to my own actions, in retrospect, I certainly concede that they could have been done somewhat differently. But my basic responsibility in the agency is to see that the funds provided to my agency, in my area, are invested so that we get the most information possible from those resources and the results as truly unbiased as possible.

The decision I made seemed a proper decision at that time, based on the evidence before me.

As to question 2, the adequacy of the basis for the recommendations and the good faith requirement, both Dr. Weyzen and Dr. Marks can speak better to these issues. I believe they acted in good faith as did all reviewers both internal and external over the full term of the program. I do not believe there was any action taken other than in good faith. If I may speak to that point just one moment, I think it is important for the committee to review with me the timing of the recommendation for termination of that program and the subsequent movement of Dr. Marks to Battelle.

The decision to move the programs to the Oak Ridge Associated Universities was made in late 1974 or early 1975 and Dr. Mancuso was so informed. It was not until the late spring of 1976, 1 year to 18 months later, that Dr. Marks began considering where he would spend the next several years of his scientific career. Thus, in my view, the two decisions were totally unrelated.

Let me, personally, take the responsibility for reprograming the work in the Battelle-Pacific Northwest Laboratories in mid-1974, in order to have an independent and more detailed analysis of the Milham data. That program has continued. That is the one in which Dr. Gilbert is currently involved. Certainly, as I pointed out to the committee yesterday, if these data were, in fact, related to radiation causes, that is, if cause and effect between the two could be demonstrated, the agency must know it as rapidly as possible, in order to spur efforts to verify in a major way, with all the data we have, whether or not those first suggestions could be borne out as being true.

Certainly, if true, there was a clear indication that radiation standards might not be adequate. The decision in 1974 was made to move the whole program to the Oak Ridge Associated Universities.

The decision made by Dr. Weyzen in 1977 to allow the Hanford Environmental Health Foundation to analyze their own data was his decision that he made and that also an independent analysis would be made at ORAU.

As to question 3, the relations between Mancuso and his contract supervisor internally within the agency, this was a matter which the committee was exploring in detail at the close of the hearings yesterday, and I presume you wish to continue that today. If I may phrase the issue in terms of the proverbial "fox in the chickenhouse" view of placing agency work in prime contractor labs, let me only mention that the Oak Ridge Associated Universities, is an organization formed and governed by 45 Southern universities, including all the major universities in the Southeast. As you are well aware, three of these are in Florida and two are in Kentucky.

The program I am discussing here, has a separate advisory committee appointed by the governing board of ORAU, reporting to that board directly and through them to presidents of the 45 universities. They are charged with seeing that the proper staff is hired, that that work has the proper controls built into it for quality and integrity and, in fact, they report directly to the board members themselves.

The advantage of such an arrangement over that of a single university is that the continuity of management of scientific direction and of scientific staff addressed to major issues can be assured over a long period of time. The problems we have encountered in a single university where a professor is in charge, if he retires, if he passes away, or he resigns to go to another university, are that we are confronted with arranging with the university to see to it that that program continues. This gets into a lot of discussion. In the view of the agency, then, the movement of the program to Oak Ridge would insure not just for 3 years or 5 years, but for 30 or 40 years, an uninterrupted continuation of that program and insure preservation of the records.

Finally, with regard to question No. 5, the purpose in having Dr. Hutchison, Dr. Gilbert, Mr. Jablon, and others here, was to explore the adequacy of methodology used by Dr. Mancuso.

They can speak better than I to those issues.

Thank you, Mr. Chairman. I wanted to foscus on what I think were the five major issues the committee was trying to explore. If you wish, Dr. Weyzen can discuss the peer review, but you may wish to take some other order in your discussion.

Mr. ROGERS. Now, Dr. Liverman, you mention a decision being made, I think, in 1974.

Dr. LIVERMAN. Yes, in late 1974, early 1975. The memo which we had under much discussion yesterday and of which I think the committee does have a copy, I believe was dated December 2, 1974, and was the original recommendation.

Mr. ROGERS. And you made that decision?

Dr. LIVERMAN. Yes, sir, the buck stopped with me.

Mr. ROGERS. Now, I don't see in the memo that you refer to, that there is any discussion that suggests that your staff recommended a change in contractor.

Dr. LIVERMAN. The December 4 or December 2.

Mr. ROGERS. December 2.

Dr. LIVERMAN. I don't have that memo in front of me.

Mr. ROGERS. I recall that you said your staff had said in the memo that the peer review had recommended the change in contractor, and that is what you based your decision upon.

Dr. LIVERMAN. I do not have that memo in front of me.

Dr. MARKS. Here it is.

Dr. LIVERMAN. There are many decisions related to that time frame, and whether this is a specific memo or——

Mr. ROGERS. Well, this memo is what you told the committee was the basis of your judgment. And I don't see any such referral.

Dr. LIVERMAN. You are absolutely correct on that.

Mr. ROGERS. Well, now what is the committee to conclude, Dr. Liverman? You told us that your judgment was based on a staff memo which told you that the peer review didn't recommend that Dr. Mancuso continue with the study. Now we see the memo that you referred us to, and that recommendation simply is not there. What was the reason for the cancellation of the Mancuso contract?

Dr. LIVERMAN. I believe as we had attempted to outline for you yesterday, sir, the decision to do that was based on this memo and on the many other peer reviews, and other factors that are tied in with it.

Mr. ROGERS. Well, what peer reviews, because the majority of the peer reviewers recommended that the project continue. We went through that yesterday.

Dr. LIVERMAN. May I ask Dr. Weyzen to discuss the peer revie with you?

Mr. ROGERS. Yes, certainly.

Dr. WEYZEN. Mr. Chairman, if I may, I would probably take 1 or 2 minutes to discuss the peer review system and address some of the questions that were raised yesterday, and then go to specif points in the peer reviews over the duration of the contract th will answer your questions.

Mr. ROGERS. That will be satisfactory. I am somewhat familia with peer review. This committee has dealt with it rather extensively in NIH. You may proceed.

Dr. WEYZEN. Very good, sir.

Mr. ROGERS. I would like to have your thinking on peer revie think this would be helpful. I am at a loss to understand some the proceedings.

Dr. WEYZEN. Yes, sir.

Mr. ROGERS. So perhaps you could tell us how you view pee review.

Dr. WEYZEN. Yes, sir.

Mr. ROGERS. I know how the committee views it and how the law views it.

Dr. WEYZEN. I believe that the most important purpose of a peer review is the discussion between principal investigator and his peers concerning the scientific merit of the work that he is doing. Second, peer reviews serve to advise the program officers in the direction programs should take, and the quality of the program. I also believe, very strongly, that a program officer who is responsible for the Federal investment in the program does not have to follow the peer review, nor does he have to hide behind a peer review. He may use it as guidance in directing the program.

And if you consult the files that have been made available to the committee——

Mr. **Rogers.** And we have.

Dr. **Weyzen.** You will find that there is an almost continuous correspondence between the technical representative or program officers and the principal investigator directing him or suggesting certain directions of research that should be followed or should not be followed. I specifically direct your attention to, for instance, the correspondence on the suitability of certain control populations. I think you'll find very strong input from the peer reviewers in the direction of the program by the program officer.

Now, with regard to specific criticism of the program, I would like to go back to the 1972 peer reviews. The discussion yesterday centered around one of the reviews, and let me just quote from a short paragraph. It says:

> It is the consensus of the group that this was a highly desirable research activity and deserved continued support. We also agreed that the University of Pittsburgh should continue the contract.

I suggest to you, sir, that this was the opinion of the one reviewer, and, with your permission, I would like to read another review.

Recommendations, (1) This is really the only firm recommendation, all others are contingent. It is that you should find another contract or preferably, a university department of epidemiology to take over the study after a terminal year. (A) The present contractors after many years have failed to produce. (B) In discussion, they give me no reasons to hope that they will produce. With your permission I would skip the rest.

Mr. **Rogers.** Yes. Are you saying that this is a consensus?

Dr. **Weyzen.** I am not saying this is a consensus, sir.

Mr. **Rogers.** This is one out of five, and the only one out of five who had suggested a change of the contractor, right?

Dr. **Weyzen.** I am just trying to point out——

Mr. **Rogers.** Well, just answer the question, one out of five right?

Dr. **Weyzen.** One out of five.

Mr. **Rogers.** That is all.

Dr. **Weyzen.** I would like to read some of the comments of the other reviewers.

Mr. **Rogers.** We have read them. But overall they recommended that the project continue, and to continue with the University of Pittsburgh.

Dr. **Weyzen.** Sir, as I stated earlier——

Mr. **Rogers.** All right. As you stated earlier——

Dr. **Weyzen.** As I said earlier, peer reviewers provide guidance to the program offices.

Mr. **Rogers.** Well, I understand that. But that was given to us as the reason for canceling the contract. Now you are saying that is not really so. Now, what do you want the committee to believe?

In other words, in the written testimony given by Dr. Liverman, he says the reason it was terminated wasn't because he was going to retire, but because his staff said the peer reviewers recommended the change. But, the peer review group didn't do that at all, only one out of five.

Dr. WEYZEN. Sir, may I correct for the record one thing. The overall peer reviews, without exception, are critical of the technical merits of the program, and this was the reason it was terminated.

Mr. ROGERS. This is the point of peer review. The reviews may have made some suggestions but they still said to continue, and to continue with the contractor.

There was only one who said to change contractors, only one. Now, you have stated that the reviews were the basis of the change. It appears to us that they were not.

Mr. CARTER. Will you yield on that just a minute?

Mr. ROGERS. Certainly.

Mr. CARTER. I would like to ask why Dr. Brodsky was criticized in this peer review at the same time?

Dr. WEYZEN. Pardon, Sir?

Mr. CARTER. Yes, why he was criticized by the peer review committee, his presence on the team? Why was that?

He just was recording the dangers of ionized radiation and I notice that your peer review team criticized him, this time.

Dr. WEYZEN. Yes, sir.

Mr. CARTER. It seems to me that anyone who found anything wrong with Hanford data was on the black list, and Brodsky was just one of them. Later reports which he makes tend to show a definite relationship between that radiation and blood diseases.

Dr. WEYZEN. Dr. Carter, do I understand you——

Mr. CARTER. Yes, sir.

Dr. WEYZEN. Do I understand you to say that anybody who found something wrong with Hanford data was criticized?

Mr. CARTER. That seems to be the way it was.

Dr. WEYZEN. You mean in terms of findings of this analysis?

Mr. CARTER. Yes, sir. Whenever they find something wrong—if they find a high incidence of disease caused by radiation in the Hanford facility—then bingo in time they are phased out. Dr. Brodsky seems to be one of those people.

Dr. WEYZEN. Sir, may I point out for you.

Mr. CARTER. Yes.

Dr. WEYZEN. At this time, in 1972, the results of the longevity analysis did not show any effects of radiation whatsoever.

Mr. CARTER. How long have you been associated with this group?

Dr. WEYZEN. Since 1969, sir.

Mr. CARTER. 1969. You have never been at an atomic explosion then?

Dr. WEYZEN. No, sir.

Mr. CARTER. Have you ever been around any of the nuclear reactors?

Dr. WEYZEN. Yes, sir.

Mr. CARTER. You have? You have been close to them where you could see the core?

Dr. WEYZEN. I have worked at reactors, I have worked for 15 years at laboratories with radiation, sir.

Mr. CARTER. Did you work on the reactor, or the actual material?

Dr. WEYZEN. Actual.

Mr. CARTER. Atomic material?

Dr. WEYZEN. Right, sir. Nuclear material

Mr. CARTER. It is interesting to note that you do this. I am glad to see one fellow who really has been there. I notice that there has been some criticism of the university contract since the professor might retire or die before the work was done. So, instead, you would allocate the project to other universities affiliated with Oak Ridge Laboratory, is that correct or——

Dr. LIVERMAN. Dr. Carter.

Mr. CARTER. Yes, sir.

Dr. LIVERMAN. Dr. Carter, I think I probably should respond to that question, since it is my statement.

Mr. CARTER. Yes, sir.

Dr. LIVERMAN. The point I wish to make is that there are many things to be considered but one that must be insured is the ability to maintain and continue the viability of those records over a long period of time.

In general, with a university, when the professor goes, the department recruits another professor, and he may or may not be interested in continuing the studies that exist. Because of the importance of these kinds of records, it is felt that one needed to have a repository, accessible to all people who wish to investigate the information as independently as they might choose to investigate it, and we would welcome that. But it is most important to have those records in a place where we could insure their long-term, continued integrity, storage, and availability.

Mr. CARTER. What group could insure this long-term integrity and continuity more than the Center for Disease Control in Atlanta? We know that the CDC is an independent agency and that it has excellent researchers. Why didn't you use them? Why not let CDC continue with the project? Why have you decided not to use them except as——

Dr. LIVERMAN. We have made no decision not to use them

Mr. CARTER. Well, let me describe the situation to which I am referring. There was a meeting in December with various representatives from DOE, the VA, the Pentagon, and CDC.

Dr. LIVERMAN. I was not there. Yes; I know the meeting to which you refer.

Mr. CARTER. All right, sir. And in that meeting it was decided that CDC would conduct only the research on the atomic blast, "Smoky." The larger study was to be given to another agency but funded by DOE, DOD, and the Veterans' Administration—is that not correct?

Dr. LIVERMAN. I think that——

Mr. CARTER. I have been here long enough to have seen that in-house investigations are usually inadequate. They tend to sweep everything under the rug. Today I read from the paper about this problem on a different subject where there was an alleged coverup by an in-house investigation. I don't doubt it. I have seen this too many times. They won't find anything wrong with their own house; they just don't do that.

Dr. LIVERMAN. May I respond to your question, sir?

Mr. CARTER. Yes, sir.

Dr. LIVERMAN. The question was what happened in that meeting. I was not in that meeting, but I believe it is true of Federal agencies that no committee of Federal agencies can deny or even presume to deny any one of the others an independent investigation of anything. I think the decision which was made there was that it was a consensus of the group around the table, including the CDC, that an appropriate home for such a study in which multiple agencies had an interest was in the National Academy of Sciences.

Any one of the agencies could continue on their own, but to support that work in the National Academy of Sciences, freely accessible to all the scientific community for their input, was the intent and the hope of the decision which I believe that interagency group made. And on that basis, I believe three of the agencies or perhaps four, I don't know, decided to contract out with a steering committee to guide the whole group to insure the integrity of the studies that were done.

Mr. CARTER. If you wanted long-term continuity, why wasn't that decision made at the beginning of the Mancuso contract?

Dr. LIVERMAN. That is a very good question, to which I have no answer.

Mr. CARTER. Yes, sir, all right. Was it later on when the Mancuso study showed adverse findings to your consensus, that the decision to terminate was made?

Dr. LIVERMAN. The decision about the Dr. Mancuso study was made before such findings existed, not after.

Mr. CARTER. Sir?

Dr. LIVERMAN. The decision concerning Dr. Mancuso's program was made before those findings were evident, at all. Not after they were made. The decision to transfer was made in 1974, early 1975. The study results were reported to the agency, I believe for the first time, in a cursory way in June of 1976 and a detailed report was given by Dr. Mancuso at the Health Physics Society meeting in October 1976. I believe that he briefed our staff in September 1976, some 2 years after the decision had been made to move the program.

Mr. CARTER. Did Dr. Mancuso know in 1974 that you were moving him?

Dr. LIVERMAN. I would have to rely on my staff who contacted Dr. Mancuso.

Dr. WEYZEN. No; he was informed on March 5, 1975, in a meeting that this was going to be done.

Mr. CARTER. That he would be transferred?

Dr. WEYZEN. Yes; that the contract would be transferred.

Mr. CARTER. You stated earlier that Dr. Mancuso's study was transferred without competitive bidding. How do you make decisions on awarding contracts?

Dr. LIVERMAN. Decisions were made in different ways. It depends on the particular kind of contract; if it is a straight procurement of potatoes or trucks or some such thing, you go out and bid competitively. In the biomedical area, as I think this committee is fully aware, these matters are done by unsolicited proposals submitted by independent investigators wherever they may be.

And those are reviewed and hopefully judged on their scientific merit basis and then approved or not. This particular one because it—and I think this is an important point—involves records which physically exist and people who physically exist in these various laboratories can best be handled, dealt with, and worked with where they are normally kept. This is also true of physical, medical, and related kinds of examinations.

Mr. **Carter**. And if you know them and have worked with them, then it's a little easier to make such a decision, isn't it?

Dr. **Liverman**. Yes; I suspect that is true. May I give you an analogous situation?

Mr. **Carter**. Yes.

Dr. **Liverman**. There is the case of Dr. Robley Evans who for more than 20 years worked at the Massachusetts Institute of Technology.

Mr. **Carter**. Yes, sir.

Dr. **Liverman**. You are probably familiar with his work on radium dial painters. When Dr. Evans got ready to retire from the university, he requested not just us but the Joint Committee on Atomic Energy of the Congress to transfer his records and all of the records that pertained to the studies he was doing to the Argonne National Laboratory. He preferred to turn them over to investigators there in preference to MIT so as to insure their continued integrity over a long period of time.

Dr. Evans is still alive. You can certainly call him and ask him the basis for that decision. This is a similar type of decision, at least in our view.

Mr. **Carter**. In this case this was a professor at a different university, and he offered the continuity which you said you were desirous of obtaining.

Dr. **Liverman**. He offered it by moving——

Mr. **Carter**. On the other hand, the University of Pittsburgh dosen't offer you that continuity; is that correct? That is what you said just now.

Dr. **Liverman**. I did not speak for the University of Pittsburgh. I do not know the answer to that question.

Mr. **Carter**. Well, Dr. Mancuso is a professor at the University of Pittsburgh, and in his case you said that he wouldn't provide the continuity. Certainly I would compliment the gentleman from the Massachusetts Institute of Technology, a university for which I have high regard. But according to your own statement over the years we have seen the buddy system work in Government here. And we must admit, Dr. Liverman, that Dr. Marks and Dr. Weyzen worked together. How many years have you worked together gentlemen?

Dr. **Marks**. We worked together——

Mr. **Carter**. Yes, sir.

Dr. **Marks**. We worked together in the same component of the organization from December 1971 to the summer of 1973, when we were transferred into different components.

Mr. **Carter**. So, you worked together. How long have you known each other?

Dr. **Marks**. We have known each other since December 1971.

Mr. **Carter**. Yes, sir, you were associated together. You saw each other pretty frequently from that time on to the present; is that not true?

Dr. **Marks**. More or less.

Mr. **Carter**. More or less; yes, sir. I would think more, rather than less. And then Dr. Marks, you made the decision after the contract was taken from Mancuso, to go to Battelle Laboratories. Is that correct?

Dr. **Marks**. Yes, sir.

Dr. **Weyzen**. That is not correct.

Mr. **Carter**. We have seen this before when bureaucrats have gone from the Government to private industry and then draw tremendous salaries. It seems that some of our corporations along with these former bureaucrats have a unique way of getting grants from the Federal Government. By the way, how much funding is the Federal Government giving Battelle Laboratories at the present time?

Dr. **Marks**. Excuse me, Dr. Liverman advised that——

Mr. **Carter**. Yes; would you answer that: How much funding?

Dr. **Liverman**. Let me address your question in general.

Mr. **Carter**. All right. Well, no; I don't want a general answer, I want a specific answer.

Dr. **Liverman**. I am going to answer.

Mr. **Carter**. What is the level of funding?

Dr. **Liverman**. We did not transfer as a result of Dr. Marks——

Mr. **Carter**. Wait a minute, now, I haven't asked you that. What contract do you have now with Battelle Laboratories and what is the amount of that contract?

Dr. **Liverman**. The contract with Battelle Laboratories now is a prime contract signed for a 5-year period by the Department of Energy to conduct all the activities of the agency.

Mr. **Carter**. Signed when?

Dr. **Liverman**. I would have to see the records. It was renewed September 30, 1974, by the Energy Research and Development Administration.

Mr. **Carter**. I see, September 30, 1974, wasn't it?

Dr. **Liverman**. Yes, sir. That is the correct date.

Mr. **Carter**. Yes; that was the time you went to Battelle Laboratories, too; wasn't it 1974?

Dr. **Liverman**. I can assure you, sir,——

Mr. **Carter**. I am asking Dr. Marks.

Dr. **Marks**. I went to the Battelle-Pacific Northwest Laboratories in 1974.

Mr. **Carter**. In 1974, the same year.

Dr. **Marks**. May I——

Mr. **Carter**. Mancuso's study was taken away from him, and we have Dr. Stewart here who has checked these studies and says that they are good. And she happens to be one of the most brilliant people I have ever seen appear before this committee. DOE took Mancuso's study away, and now who is doing a portion of it—that old in-house companion is now doing his project.

Dr. **Liverman**. May I comment, sir.

Mr. **Carter**. Yes; you may comment. And is this right?

Dr. **Liverman**. There are some facts which you have given which are correct; yes, sir.

Mr. **Carter**. If there are facts that are not correct, please tell me.

Dr. **Liverman**. The Battelle contract is a $58 million contract.

Mr. **Carter**. $58 million.

Dr. **Liverman**. $58 million.

It is managed by Battelle-Pacific Northwest Laboratories, which is a part of Battelle Memorial Institute.

Mr. **Carter**. Yes, sir.

Dr. **Liverman**. We did not, as a result of Dr. Marks' moving to Battelle, move any money in addition to that which was already there to accommodate Dr. Marks in any way.

Mr. **Carter**. But it was an unusual situation in that $58 million and Dr. Marks went to Battelle about the same time; is that not true?

Dr. **Liverman**. Well, I believe the point that I made has been made. The amount of the contract was approximately $58 million a year. Dr. Marks has nothing to do with the administration of that contract.

Mr. **Carter**. Of course not.

Dr. **Liverman**. And his ability to influence the decision of whether the Department of Energy did or did not assign that contract to Battelle——

Mr. **Carter**. Who arranged that contract?

Dr. **Liverman**. The contract was authorized by the AEC, executed by the AEC operations office manager, and its effective date was January 1, 1975, through September 30, 1979.

Mr. **Carter**. Upon whose recommendation?

Dr. **Liverman**. Upon the recommendation of the Richland Operations Office. We have about 300 civil servants there, who not only manage that one but some 500 other contracts.

Mr. **Carter**. Did you recommend this?

Dr. **Liverman**. Did I recommend? I did not have any basic disagreements with the contract as it was proposed in a broad R. & D. management process. That contract, as renewed, does not specifically discuss any of the detailed programs of the assistant administrators.

Mr. **Carter**. Well, it is passing strange that these contracts tend to happen between those bureaucratic buddies whom we read about all the time. Thank you, Mr. Chairman.

Dr. **Weyzen**. Mr. Chairman, may I make a comment?

Mr. **Rogers**. Yes.

Dr. **Weyzen**. I would like to briefly talk about this particular project. In 1974, I believe, when Dr. Milham's results were disclosed, the Battelle people were requested to look at Dr. Milham's findings and they have been doing so for the past few years. It was not until October 1976, that I became responsible for the project to analyze the Hanford data.

Now, with regard to funding, the funding in 1976 was $105,000 and since then has gone down to $100,000. So, no additional money was provided to Battelle as a result of the transfer of the contract.

Mr. **Rogers**. As a matter of fact, the foundation for this was laid, really, on February 20, 1973; was it not, Dr. Marks, in your recommendation for a change of contractor, and how it ought to be handled?

Dr. **Marks**. Yes, sir.

Mr. **Rogers**. Could you read for us, beginning on page 5 of that memo, dated February 20, 1973, under "alternate course of action."

Dr. MARKS. Yes, sir.

> One, retention of the contractor. Retention of the contractor without change would be an unsatisfactory solution. Although increasing progress is being made in the analysis and production of results, the unrealistic goals and weaknesses in their understanding of radiobiologic considerations and in their capacity for publication remain.
>
> If the contractor's methods that entail the use of SSA, that is Social Security Administration, information and resources prove to be the only or best available for this study, retention of the contractor may be the only practical alternative. In parentheses, see above discussion 2D.

Mr. ROGERS. Yes, if you will now go to page 6, item 2.

Dr. MARKS [reading]:

> Early replacement of the contractor. Such a move, although justified on the basis of performance may have undesirable consequences. Unless an immediate replacement is found, a public charge may be made that the AEC is stopping this program out of fear that positive findings will emerge.

Mr. ROGERS. Now, let's pursue that a moment. What would be the undesirable consequences and who would make such a charge that the AEC is stopping this program out of fear that positive findings will emerge.

Dr. MARKS. The fear was that the contractor might react and institute public charges to the effect that his contract was terminated improperly.

Mr. ROGERS. And was there a concern that positive findings would be of real concern to the AEC?

Dr. MARKS. There was no concern about legitimately arrived at positive findings. In fact, it was the intent of the AEC to develop either negative or positive findings, whatever the study would produce in its normal, natural manner. And I may point out that until that time all the findings by the contractor had been negative. So that on the basis of his performance, there were no positive findings at that point.

Mr. ROGERS. When did you first know his findings might be positive?

Dr. MARKS. I first learned of it indirectly in September of 1977.

Mr. ROGERS. 1977?

Dr. MARKS. 1976, excuse me.

Mr. ROGERS. You didn't know it before that?

Dr. MARKS. No; I didn't.

Mr. CARTER. Mr. Chairman. Where were you, Dr. Marks, in September 1976?

Dr. MARKS. I was at Battelle.

Mr. CARTER. At Battelle Laboratories?

Dr. MARKS. Yes, sir.

Mr. CARTER. You have severed your connections then with DOE?

Dr. MARKS. Yes; I had. At that time——

Mr. CARTER. Then how could you, being at Battelle, have affected the Mancuso study? You were no longer in position to do that. Weren't you employed by a private group?

Dr. MARKS. Yes; I was invited along with Mr. Heid of the Battelle Laboratories to go to Pittsburgh to be briefed by Dr. Mancuso and Dr. Stewart concerning their new findings. He wanted to discuss his findings in advance of presenting a paper to the Health Physics Society.

Mr. **Rogers**. Well, now, why was it you suggested then in 1973, in your memo, that a charge might be made that AEC is stopping the program out of fear that positive findings will emerge, if there had been no positive findings?

Dr. **Marks**. Because the agency is under a certain amount of suspicion at all times with regard to the nature of the findings that——

Mr. **Rogers**. But this is an independent study; the agency wasn't doing this work.

Dr. **Marks**. It wasn't a question of the study itself, but of the termination of the contract.

Mr. **Rogers**. Well, if there were no positive findings, why would that bring into play the fear that positive findings might emerge?

Dr. **Marks**. In fact, positive findings have emerged in Dr. Mancuso's study.

Mr. **Rogers**. Well, I understand that. And there have been attempts to cover them up, and the contract taken away from the man who found them. That is the point we are getting at.

And you even expressed that concern back in 1973. Could you read that next paragraph for me?

Dr. **Marks**. Yes, sir.

> Finding a suitable replacement under existing conditions was handicapped by general knowledge that this is Dr. Mancuso's project and that any new principal investigator will be replacing Mancuso and by implication putting him out of a job. Overtures to possible candidates may be carried out now in a clandestine atmosphere. Under these conditions, potential candidates will be unable to learn enough about the study to develop carefully prepared proposals that might be judged fairly to arrive at a proper choice of a contractor. Furthermore, the large amount of work performed to date using Dr. Mancuso's methodology may be jeopardized by a new investigator's lack of familiarity with that methodology or by poor cooperation of the Social Security Administration with the new investigator.

Mr. **Rogers**. All right, thank you. Now, let me read a portion of a letter from a reviewer, addressed to Dr. Leonard A. Sagan, Medical Research Branch, Division of Biology and Medicine, U.S. Atomic Energy Commission. I presume he was there before you?

Dr. **Marks**. Yes, he was.

Mr. **Rogers**. In 1967?

Dr. **Marks**. Correct.

Mr. **Rogers**. This man at that time says, "I recognize that much of the motivation for starting this study arises from the political assurance that AEC employees are not suffering harmful effect. Such assurance will derive from the 5-year study as already planned."

Now, do you know a Fremling?

Dr. **Marks**. Yes; I know Mr. Fremling.

Mr. **Rogers**. Did you have any dealings with him in this matter?

Dr. **Marks**. I don't recall having any direct dealings with Mr. Fremling on the Mancuso contract, but I would welcome being refreshed on it.

Mr. **Rogers**. Do you know a Dr. Alpen of PNL?

Dr. **Marks**. Yes; I do.

Mr. **Rogers**. I would like to read from a draft memo regarding the Mancuso/Milham studies, dated July 17, 1975, "Earlier this week, Ed Alpen provided us with a draft report. We have gone through the report. And while we have no real expertise on our staff in terms of statistical capability," and this is the Battelle, which I think you called, did you not, Dr. Liverman, to get them to do a quick study on this when you heard that the study may be showing positive results?

Dr. LIVERMAN. They had some statisticians there to look at data, right.

Mr. ROGERS. Didn't they do that at your request?

Dr. LIVERMAN. Yes; they did.

Mr. ROGERS. Didn't you personally request it?

Dr. LIVERMAN. That I don't quite recall. It is possible but I certainly do not remember having——

Mr. ROGERS. Dr. Liverman, I believe it was done by you.

Dr. LIVERMAN. It could have been done by me.

Mr. ROGERS. In other words, you had some concern about a positive showing?

Dr. LIVERMAN. My concern was, as I tried to state in my summary statement, my position on the issue is if the information was bad we must know it because in that case we would have to—we do not set the regulations but that information needs to be brought to the attention of people who do set regulations if it was confirmed. As Dr. Milhan pointed out yesterday in his testimony, his first cut at the problem suggested there was an increased rate of cancer. The correlation between that and radiation had not been made. Dr. Gilbert had spoken to the question that what she was trying to do was to take the Milham data and relate it to radiation dose in those studies. My concern was to let us examine that data rapidly and in as much detail as possible to get the facts on the table. Questions such as, are they correct or incorrect? Can the interpretation be made that, in fact, the radiation is effective in lower doses than the scientific community previously suspected? If so, we need to accelerate our studies in the low-dose area to determine as rapidly as we can whether or not it is true.

Mr. ROGERS. Well, except for the fact you terminate the contract which was now bringing the postitive showing, and the foundation has been laid for that already. You terminate the contract of an independent scientist who is showing positive results, stop his research, and turn it over to an in-house group.

Now let me just read further. The message of the draft is clear. The Battelle analysis suggests, after they looked into the data for Dr. Liverman that Hanford has a higher proportion of cancer deaths for those under 65, than the United States as a whole, or the State of Washington as a whole. But even more disturbing from our standpoint is that in Battelle's analysis of evidence of cancer within the Hanford employees who have been exposed to varying amounts of radiation, the analysis tends to show a much higher incidence of certain types of cancers, among those who have 6R and above throughout their lifetime.

Throughout their lifetime. Now, this is contrary to what Dr. Gilbert's report concludes. I don't know that her facts are at variance, but the conclusion seems to be. From this, Battelle, in the report concludes that they have "established a relationship between cancer as a cause of death and a total external dose of radiation received—the total over a lifetime, even though the exposures have been within the permissible amounts. The relationship is particularly pronounced for lung cancer. In essence, where we are is that we hoped to get a good answer to the Milham report, and instead it looks like we have support for it."

Dr. **Marks**. Mr. Chairman.

Mr. **Rogers**. Yes.

Dr. **Marks**. May I point out that the studies by the Battelle scientists were conducted in three phases. Initially the request was made to the Battelle statiticians to analyze the same body of data as Dr. Milham did in somewhat the same manner, that is to calculate proportional mortality ratios on the same deaths which represented about 25 percent of the total number of deaths in the data base that Dr. Mancuso had accumulated. It was projected that subsequently the analysis would be extended to all the deaths, which would number between 3,000 and 4,000. The initial examination by the Battelle scientists supported Dr. Milham's findings. when the subsequent extension to the full number of deaths was conducted and the data were analyzed, those findings were weakened somewhat. When, in accordance with the original plan, the population at risk was taken into consideration, the results that Dr. Gilbert is providing were obtained and did indicate an effect with respect to cancer of the pancreas and multiple myeloma. Those results did appear, but effects with respect to overall cancer mortality and mortality in general were not supported with this more refined study.

Mr. **Rogers**. The Battelle study?

Dr. **Marks**. Yes. Dr. Alpen's original letter was drafted after the very preliminary phase. I think he would have reached a different conclusion if he had waited until the second and third phases of this study were completed.

Mr. **Rogers**. But then you stopped the contract for the study that did confirm the Milham study, and gave it to somebody else. Let me read further from these draft notes.

> Shortly after this meeting the manager and I talked to Dr. Liverman, who described the specific authority, PNL report. We sent a copy of the report to Dr. Liverman the next day. Dr. Liverman fully grasped the significance of the findings and was anxious to have a peer review in headquarters

Dr. **Liverman**. Yes, sir.

Mr. **Rogers**. Now, on July 25, 1975, Alpen called to say that he had a green light from Liverman to get going on an all-out study to complete the work. The manager pointed out the urgent need for answers and expressed his satisfaction to the headquarters to fund this work. At this meeting also Alpen said he would be more than willing to respond to R. & L. in response to the inquiries and to work closely with us to develop position papers. Now, you have got Battelle to do this study. But we hear from a letter dated October 1, 1976, Oak Ridge Associated Universities, from Edythalena Tompkins, regarding the Battelle study.

In the first page of the letter it states the Battelle study will be published after appropriate peer review. It is our understanding that in spite of all of the data Battelle recovered from Dr. Mancuso, no reports are to be published, either by Battelle or Oak Ridge.

So we're not going to let the public know.

Dr. Godbold and I have spent several hours trying to determine exactly what has been done to obtain the data presented in the 1976 document, and therefore what interpretation of the data is valid. It is obvious that the authors do not understand the meaning of the calculation of common epidemiological terms such as standard mortality ratios.

Dr. MARKS. I would disagree with that.

Mr. ROGERS. Well, this is what they are saying. "Consequently, tables are labeled, standard mortality ratios, when indeed they are proportional mortality ratios and there are other ratios presented which are described as population based mortality ratios." And yet you stopped a study and give it to these people.

Dr. LIVERMAN. Mr. Chairman.

Mr. ROGERS. And then if Mrs. Tompkins is wrong, which you say now that she is, why they did you give the other half of the study to her?

Dr. MARKS. Sir, I think there was an error in the draft document that the Battelle statistical group prepared. It involved mislabeling proportinated mortality ratios so that they were called standardized mortality ratios.

Mr. ROGERS. Well, they had never done any epidemiological study on humans.

Dr. MARKS. Dr. Gilbert was trained and obtained a Ph. D. in the study of biostatistics and epidemiology.

Mr. ROGERS. The testimony today is that other scientists agree with her figures, but disagree with her conclusions from the figures.

Dr. MARKS. Well, there is a great deal of dispute among scientists.

Mr. ROGERS. I understand that. It apparently can be rather heavy. We are trying to find out why in spite of peer review you have cut off the contract, and given it to people inhouse to do it.

There is a call to the floor. The committee will recess for 10 minutes.

[Brief recess.]

Mr. ROGERS. The subcommittee will come to order, please, to continue our hearings. Dr. Carter.

Mr. CARTER. Thank you, Mr. Chairman.

Mr. ROGERS. Could we have order, please, in the committee.

Mr. CARTER. I would like to get some clarification on the current occupational safety exposure to radiation. We have heard that it was 5 rem per year, but it is my understanding that NRC regulations permit higher exposures of 3 rem per quarter, or 12 rem per year up to the time when a worker reaches a certain quota based on his age.

Dr. LIVERMAN. Could you pull the mike a little closer?

Mr. CARTER. Yes. It is my understanding that NRC regulations permit higher exposures of 3 rem per quarter, or up to 12 rem per year, up to the point where the worker reaches a certain limit based on his age, and then after that point the standard of 5 rem per year applies. Is this correct?

Dr. WEYZEN. Dr. Carter, I am not familiar with that regulation; maybe you coud read it to us.

Mr. **Carter.** You are not familiar with this regulation? What is your official position at the present time?

Dr. **Weyzen.** I am familiar with the exposure regulations that say 3 rem per quarter or a total exposure of 5 rem per year but I don't know about this one.

Mr. **Carter.** What is your official position at the present time, sir?

Dr. **Weyzen.** I am the manager of human health studies program in the Division of Biomedical Research.

Mr. **Carter.** You are the manager of what?

Dr. **Weyzen.** Human health studies program.

Mr. **Carter.** Human health studies program with NRC, is that correct?

Dr. **Weyzen.** No, sir; with Department of Energy.

Mr. **Carter.** This regulation comes from the January 1977 Nuclear Regulatory Commission. It requires that a licensee may permit an individual in a restricted area to receive a dose to his whole body greater than that permitted under paragraph 5(a), which is the 5 rems per year, to which you referred. The formula which permits greater yearly exposure is as follows:

> The dose to the whole body, when added to the accumulated occupational exposure does to the whole body, shall not exceed 5 (N-18) rems, where "N" equals the individual's age in years at his last birthday; * * *

And by this method, an individual could receive more than the 5 rem per year, which you have stated is the maximum allowable dose. I would like to include the full text of this regulation for the record.

[The regulation referred to follows:]

PERMISSIBLE DOSES, LEVELS, AND CONCENTRATIONS

§ 20.101 Exposure of individuals to radiation in restricted areas.

(a) Except as provided in paragraph (b) of this section, no licensee shall possess, use, or transfer licensed material in such a manner as to cause any individual in a restricted area to receive in any period of one calendar quarter from radioactive material and other sources of radiation in the licensee's possession a dose in excess of the limits specified in the following table:

	Rem per calendar quarter
1. Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads	1¼
2. Hands and forearms; feet and ankles	18¾
3. Skin of whole body	7½

(b) A licensee may permit an individual in a restricted area to receive a dose to the whole body greater than that permitted under paragraph (a) of this section, provided:

(1) During any calendar quarter the dose to the whole body from radioactive material and other sources of radiation in the licensee's possession shall not exceed 3 rems; and

(2) The dose to the whole body, when added to the accumulated occupational dose to the whole body, shall not exceed 5 (N-18) rems where "N" equals the individual's age in years at his last birthday; and

(3) The licensee has determined the individual's accumulated occupational dose to the whole body on Form NRC-4, or on a clear and legible record containing all the information required in that form; and has otherwise complies with the requirements of § 20.102. As used in paragraph (b), "Dose to the whole body" shall be deemed to include any dose to the whole body, gonads, active bloodforming organs, head and trunk, or lens of eye.

Dr. WEYZEN. Dr. Carter, if I am correct the IRP Report 26 which was issued this past year—I am pretty certain of this—recommends a total exposure per year not to exceed 5 rem.

Mr. CARTER. That is to be proposed but it is not——

Dr. WEYZEN. It has been proposed, yes.

Mr. CARTER. It has been proposed but it is not adopted. And I am reading the regulations from the Code of Federal Regulations, 10 part zero to 199, revised as of January 1, 1977. And it contains the formula which I've described. So for a person aged 25, you take the formula with 25 for "N," 25 minus 18 is 7, times 5 is 35, which would permit a total of 35 rem to an individual. We presume that there would be no more than 12 rem per year, but for almost 3 years he could receive 12 rem a year rather than 5 rems.

And it is my understanding, gentlemen, that you usually employ younger men in this area and that when they reach this total they are let go. Some call this process burning out. Also, men of middle age are often placed in areas where radiation is in a middle range, and older people are in areas of lesser radiation exposure.

Dr. LIVERMAN. May I speak to you question, sir?

Mr. CARTER. Yes, you may.

Dr. LIVERMAN. The regulations are set in order that one should not exceed those under any normal circumstances. The history of the application of those regulations and the performance in the Atomic Energy Commission, ERDA, DOE in its own facilities have with rare exception reached that level—with very rare exceptions.

Mr. CARTER. That is what you say is correct, yet your regulations do permit as much as 12 rem per year, is that not true?

Dr. LIVERMAN. Yes. The regulations are meant to set upper limits.

Mr. CARTER. What?

Dr. LIVERMAN. Pardon me, sir?

Mr. CARTER. What are the levels?

Dr. LIVERMAN. I believe you have just given us those.

Mr. CARTER. All right; and we've learned that 5 rem may not be the maximum upper limit in all cases, as we have heard during these hearings.

Dr. LIVERMAN. Sir, I don't know what the discussion was about concerning the regulations but it seems to me the issue is: To what are the people exposed, not what the regulation necessarily——

Mr. CARTER. But it was stated before this committee that up to 3 rem per quarter or 5 rem per year are the so-called permissible levels.

Dr. LIVERMAN. I have no argument about that.

Mr. CARTER. All right. But then we find that NRC regulations published January 1, 1977, permit, under certain circumstances radiation exposure of up to 12 rem per year.

Dr. LIVERMAN. Our attempts are in every instance—and I believe the recorded history, which is available in the public domain already, says that, with rare exceptions, and I stress this, those limits have never been reached, much less exceeded, although I am sure there are instances in which they have been exceeded, so the object always is to keep it as low as possible.

Mr. CARTER. Let me understand you, Doctor. Could you repeat that? It is very interesting if you are saying that your records show that the limits have never been reached but you are sure that they have been.

Dr. **Liverman**. If that is what——

Mr. **Carter**. Didn't you say that?

Dr. **Liverman**. I hope that is not what I said.

Mr. **Carter**. That is the way I understood you. Would you repeat it now?

Dr. **Liverman**. OK. The regulations are in place; and those are, as you indicated, issued by the Nuclear Regulatory Commission. Department of Energy does not issue regulations. We abide by the regulations issued by EPA and NRC.

Now, with those regulations in hand, those are guidelines which we utilize for guiding and making decisions about people who are employed in our facilities. As I mentioned, those are the upper limits, which we hope to pass.

The history of workers in the atomic energy industry may be seen in this table which I would like to present.

[The following information was received for the record:]

RADIATION EXPOSURES

In accordance with its health and safety responsibilities, the AEC conducted its activities in such a manner as to assure that employee radiation exposures were reduced to the lowest practical levels within established limits. To carry out this responsibility, it was necessary for the AEC and its contractors to monitor routinely all employees who might receive a significant radiation dose.

AEC and AEC contractor employee exposures for the past 28 years are summarized in Chart VI. This chart shows that during this 28-year period over 99.8% of the employees monitored received an annual dose of less than 5 rem and that over 94.8% received one rem or less. The majority of exposures in excess of five rem in a year resulted from accidental situations. The more significant (15 rem and over) of these accidental exposures are briefly summarized in Appendix B.

During the 32 years of operation of the AEC and its predecessor, radiation resulted in a very small percentage (0.4) of the total lost-time injuries from all causes as indicated in Chart VII. These specific radiation exposures were classified as lost-time injuries as defined in the American National Standards Institute methods for reporting work injuries, ANSI Z16.1–1967 (Rev. of Z16.1–1954) and AEC directives.

CHART VI
RADIATION EXPOSURE OF AEC AND AEC CONTRACTOR PERSONNEL TO WHOLE-BODY PENETRATING RADIATION

YEARS	REM DOSE				
	0-1	1-5	5-10	10-15	>15
1947-54	130,128	6,311	284	32	0
1955	88,700	2,157	236	41	1
1956	38,225	2,312	100	4	3
1957	45,510	2,424	83	5	1
1958	59,456	6,271	158	10	12
1959	71,800	3,912	64	2	1
1960	77,822	4,829	41	2	1
1961	90,061	5,174	40	3	0
1962	122,437	5,707	113	0	0
1963	107,788	5,472	80	0	1
1964	122,711	4,157	86	11	0
1965	128,300	5,671	175	8	0
1966*	121,522	5,242	167	0	2
1967*	102,510	5,767	108	1	0
1968	103,208	4,770	4	0	0
1969	90,625	4,208	4	1	0
1970	92,186	4,464	12	0	0
1971	90,640	3,661	12	1	1
1972	86,877	3,373	10	0	0
1973	89,071	2,903	3	0	0
1974	73,846	2,318	3	0	0
TOTAL	1,818,774	94,549	1,835	121	45

* Totals for 1966 and 1967 differ from those shown in previous editions of this publication, due to the discovery of an error in the radiation exposure records of one major contractor.

Mr. Carter. Now, Dr. Marks, when did you go to work at Battelle Laboratories?

Dr. Marks. I went to work there in June 1976.

Mr. Carter. June 1976?

Dr. Marks. Yes, sir. May I point out that my duties were to be of an administrative character in connection with a number of projects in the health environmental and safety area with only minimal involvement in this project.

Mr. Carter. You were not to take over; part of the work of Dr. Mancuso?

Dr. Marks. Yes; I was not to take over Dr. Mancuso's work.

Mr. Carter. You were not to take over, is that correct?

Dr. Marks. That is correct.

Mr. Carter. Are you by profession an epidemiologist?

Dr. Marks. I am by profession a pathologist and biostatistician with training in epidemiology.

Mr. Carter. With training in epidemiology?

Dr. Marks. Yes.

Mr. Carter. And what had been your major field of work previously—as a pathologist, as a biostatistician or as an epidemiologist—in your work for the Department of Energy?

Dr. Marks. My original work was in the practice of pathology and in doing experiments——

Mr. Carter. Was it with the Department of Energy?

Dr. Marks. No; that was earlier.

Mr. Carter. All right; I want to know the history of your work with the Department of Energy.

Dr. Marks. My work——

Mr. Carter. As related to agencies.

Dr. Marks. Yes. I served as coordinator for human studies and biostatistics, so that I was functioning as an epidemiologist and biostatistician.

Mr. Carter. Biostatistics are studies of life, aren't they? Really that would be the meaning of it, would it not?

Dr. Marks. It is essentially biological.

Mr. Carter. Bio means life, statistics concerning that, and really goes back to epidemiology, doesn't it?

Dr. Marks. Yes; they are very closely related, sir.

Mr. Carter. All right. Have you done any work on the Hanford study, Mancuso's project?

Dr. Marks. I have consulted with Dr. Gilbert, who is carrying out the work, in a very modest fashion, involving only about 5 percent of my time. After the issue of the termination of Dr. Mancuso's contract came up I have been more heavily involved because of public attention in the matter.

Mr. Carter. Let's see, now; you had known back as far as 1974 that the Mancuso study was to be terminated, and you had left the Department of Energy prior to the time the contract was finally terminated, had you not?

Dr. Marks. I had left DOE in 1976, but Battelle received many inquiries from the press with regard to Dr. Mancuso's work and the question of his contract termination.

Mr. Carter. What exactly is your work, and what has it been, with Battelle if it has not been primarily with the Mancuso study?

Dr. MARKS. My principal work is coordinator of fossil studies of a health and environmental character, principally related to oil shale and coal liquifaction. I am also somewhat involved in a study of possible deaths in connection with products of coal combustion products. I have some interest in that study as well. The bulk of my activity is not related to the nuclear field at Battelle.

Mr. CARTER. It has not been related to the Hanford project until recently and, since then, only 5 percent of your time has been devoted to this?

Dr. MARKS. Yes, the mortality study, yes, sir.

Mr. CARTER. The mortality study?

Dr. MARKS. Yes.

Mr. CARTER. It is rather strange that a pathologist would start working on oil shale and things of this nature as I see it. When was Mancuso's project let to Battelle Laboratories, on what date?

Dr. MARKS. The work that could be considered Mancuso's project was let on October 1, 1977.

Mr. CARTER. Nineteen seventy——

Dr. MARKS. Seven.

Mr. CARTER. 1977.

Dr. MARKS. And this was really a continuation of the work that Dr. Gilbert had been doing relative to Dr. Milham's study.

Mr. CARTER. Yes.

Dr. MARKS. And with no increase in funding or a very nominal increase.

Mr. CARTER. Have you found that radiation in Hanford caused an increased incidence of cancer of any form?

Dr. MARKS. Yes.

Mr. CARTER. You have found that at Hanford? You make that statement?

Dr. MARKS. At Hanford the evidence is that there is a relationship of radiation exposure to carcinoma of the pancreas and multiple myeloma. I think I would find it necessary to qualify that. The study has not yet taken up other types of exposures that the same people have been subjected to, so that I think a final decision with respect to this should be held in abeyance.

But the evidence at this point is that there is a correlation between level of radiation exposure and mortality from cancer of the pancreas and multiple myeloma.

Mr. CARTER. You don't find it associated with any other form of cancer, is that correct?

Dr. MARKS. Our present evidence there indicates that there isn't an association with other forms of cancer.

Mr. CARTER. I'd like to ask you a question since you are a biostatistician and an epidemiologist. As you may know, there was a nuclear atomic blast called Smoky on August 31, 1977, in Nevada. Of some 2,235 men wearing film badges at that time, 447 have been checked and, of that number, 8 have leukemia. Would you consider that finding to be statistically significant, in view of the fact that for men of that age group normally we would expect leukemia in 4.1 cases out of 100,000? That is the average incidence. Would you consider 8 of 2,235 statistically significant?

Dr. MARKS. I wouldn't want to give a firm answer but my guess would be that it probably is statistically significant.

Mr. CARTER. You think that it probably is. All right; thank you, Mr. Chairman.

Mr. ROGERS. It appears from the testimony so far that what we have developed is that the Milham study becomes known in 1974 and then, Dr. Liverman, you asked Battelle to look at that.

Dr. LIVERMAN. Yes, sir; that is correct.

Mr. ROGERS. The early Battelle analysis, in effect, confirmed the Milham finding. You authorized and expanded the Battelle study?

Dr. LIVERMAN. To look at the remainders of the population, that is correct.

Mr. ROGERS. And that was in July of 1975. Now, in August of 1975 a press release was issued?

Dr. LIVERMAN. Was that 1975 or 1974?

Dr. MARKS. If I may interrupt, I think that was a press response.

Mr. ROGERS. All right.

Dr. MARKS. I don't think that there was a press release, but I may be in error.

Mr. ROGERS. We have copies of a press release that was proposed for August 11, 1975. It says:

> A special study of the cause of death among former employees at government installation, Oak Ridge, Tenn., and Hanford, was announced today by Federal Energy Administration. The analysis would be correlated to atomic radiation, et cetera.

Dr. LIVERMAN. Is that out of the Richland Operations Office, then?

Mr. ROGERS. The office at Richland will be contacted by members of Battelle in Richland. The system is a study of blank—had not yet been filled in. The Hanford and Oak Ridge study will involve analysis of health records, employment history, radiation exposure and death certificates, and so forth. And here again there is no——

Dr. MARKS. I stand corrected, Mr. Chairman.

Mr. ROGERS. And I think, in this, Alpen said a comparable population of workers is needed to place study findings in proper perspective. But I thought Dr. Gilbert said that wasn't true, and was never done.

Dr. LIVERMAN. I believe that the issue, if I may speak to that issue——

Mr. ROGERS. Certainly.

Dr. LIVERMAN. As I understood it at that time, the question was whether there was something unique about the Hanford population because of the environs in which they live as contrasted to, say, the Oak Ridge group or Los Alamos group or some other group; was there perhaps some unexpected aspect perhaps not radiation, perhaps radiation, but at least an issue which I thought should be addressed.

And it was for that reason that I said: Look, we have got to do studies on Hanford, studies on Oak Ridge, studies on different populations to try to rule out or incorporate, as the fact might reveal, whatever those extraneous factors if there were any, or to confirm or deny the findings as they had been made in Richland. Would you like to have Dr. Gilbert comment?

Mr. ROGERS. Yes.

Dr. GILBERT. Well, I would just like to say a little bit about my whole involvement in this study since it keeps coming up.

Mr. ROGERS. Yes.

Dr. GILBERT. As Dr. Marks has indicated, originally I became involved to check out Dr. Milham's results, which were: About a quarter of the total deaths that had occurred——

Mr. ROGERS. For whom were you working then?

Dr. GILBERT. Battelle.

Mr. ROGERS. Were you an employee of Battelle or under contract?

Dr. GILBERT. Yes, I was an employee of Battelle.

Mr. ROGERS. You were an employee of Battelle?

Dr. GILBERT. Yes

Mr. ROGERS. All right.

Dr. GILBERT. As a result of these original results based on this small sample, it did bear out Dr. Milham's findings. As a result of these positive findings we were funded to continue the study even though the other evidence, from Mancuso and Dr. Sanders was negative. But we were funded to continue our work as a result of positive findings.

Mr. ROGERS. On Milham?

Dr. GILBERT. Our own confirmation of these; we were asked to continue to explore this.

Mr. ROGERS. Yes. Had Battelle ever done epidemiological studies on humans before?

Dr. GILBERT. I am probably the only one there who has had specific training in this area, and I was not employed by Battelle until 1973, so there was no reason for them to do such studies prior to that time.

Mr. ROGERS. Thank you. Now if I may interrupt and then I will let you continue, was there peer review in awarding this contract?

Dr. LIVERMAN. Mr. Chairman, there was no contract awarded; we redirected ongoing efforts at that time to do this analysis.

Mr. ROGERS. When you originally did it, was there any peer review as you would have for other contracts?

Dr. LIVERMAN. I think that one will observe, and as has been observed, in the national laboratories the reviews are done differently from those for university contracts.

Mr. ROGERS. As a matter of fact, you called them up and told them to do it, didn't you, Doctor?

Dr. LIVERMAN. I said in that particular case I considered the matter of enough urgency to reprogram actions which had been approved before, which is sometimes done under research grants, as you are well aware, if the issue is very important.

Mr. ROGERS. Yes, if it is important.

Dr. LIVERMAN. I believe that the issue we are addessing here is a very important fact if, in fact, in Dr. Milham's results he showed an increased cancer incidence in the area.

Mr. ROGERS. Yes.

Dr. LIVERMAN. But he made no comparison between the mortality rates and radiation. What Dr. Gilbert did, I believe—and she can confirm or deny that—is to link the radiation exposure data of the people who were involved in the Milham study to investigate the relationship between radiation and cancer deaths.

Mr. ROGERS. And her statistics showed some increase in cancer but her conclusions stated that there wasn't?

Mr. GILBERT. This was the very initial result and we thought we saw some suggestion of a radiation effect in that analysis. As a result of that initial study, I would say that, if I had a bias, it was that I expected to see a relationship when I analyzed the larger data base. In fact, I think I went in kind of looking for it but it simply was not there even though I looked in a lot of different ways that I considered appropriate. And there was no relationship when we looked at the larger base.

Mr. ROGERS. May I ask this: Did your larger base include recently arrived construction workers from Delaware——

Dr. GILBERT. No.

Mr. ROGERS [continuing]. Who were working there?

Dr. GILBERT. No; the original base we used were deaths that occurred in the State of Washington. A lot of Hanford workers, of course, had gone to other places and died in other States.

Mr. ROGERS. No; I am referring to people who came there to work in construction.

Dr. GILBERT. No; none of the studies of the Mancuso data——

Mr. ROGERS. You did not include those people?

Dr. GILBERT [continuing]. Did not include construction workers? No. We did not have data on them. These data are now being collected, but we did not have data on them earlier. I don't believe that Dr. Mancuso has data on those people, either.

Mr. ROGERS. So you are saying you did not include construction workers who came in to work at the Hanford plant from Delaware?

Dr. GILBERT. These were not included in these studies to my knowledge.

Mr. ROGERS. In your studies; all right.

Dr. LIVERMAN. May I respond in answer to that question, Mr. Chairman?

Mr. ROGERS. Yes.

Dr. LIVERMAN. The study which Dr. Mancuso has been carrying out is on employees or former employees of the prime contractors, and includes the construction workers who became Hanford employees but not the people who come in and work 4 days and go out. Unless they are working for one of the prime contractors, they would not be in this data base.

Mr. ROGERS. Yes. May I just ask Dr. Stewart to comment.

Dr. LIVERMAN. Yes.

Dr. STEWART. We accidentally discovered that there are people who died, I think construction workers, and I wouldn't know how they were grafted onto the Hanford data base but they are undoubtedly accounted for because, as you know, the whole thing was done by social security number. And at one point in the analysis I was sent to this desk by social security number and I was taking one of my close looks and I noticed something very odd, and that was that the dose was very strongly correlated with the social security number, which at that time meant nothing to me at all. I was in England.

But I communicated with Dr. Mancuso to find out what the basis of the social security number was and thus discovered that the first three digits described the region, and this enabled us to see that the regions count from the East to the West, thus the high rating numbers are, as far as Hanford is concerned, very largely people who live and die in Hanford and the low rating numbers are, of course, the ones from Washington on the east coast.

And so what we deduced from this is that the reason why the repeat analysis with the Gilbert data on the expanded population—all deaths, not only those in the State—had included people who were relatively not exposed—that is to say, not necessarily, themselves, construction workers, though quite likely they were—but people who were working at the time when there was construction—more construction at Hanford led to radiation exposure.

But, for what it is worth, it now seems to be the explanation of why the repeat analysis on the full Hanford data done by Gilbert used a weaker correlation with the cancer deaths than the one which is confined to the Washington State. Have I made myself clear?

Mr. ROGERS. Yes; thank you.

Do you have any comment, Dr. Gilbert?

Dr. GILBERT. I would have to think about that interpretation a bit more before I would want to comment on it.

Mr. ROGERS. Yes. Would you do that and let us have your comment for the record?

Dr. GILBERT. All right.

[The following material was supplied for the record:]

Workers employed by J. A. Jones, Inc., the prime contractor for construction at Hanford, are not included in the Hanford mortality studies. These short-term, unexposed workers, who transferred from DuPont, to whom Dr. Stewart referred, were not considered construction workers. Such short-term workers were not included in the exposure analysis carried out at PNL. They have been considered separately in the analysis in which we compared the mortality rate for Hanford workers to the rates for the U.S. population. Thus, I see no way that these workers can bias our analysis.

Dr. GILBERT. Could I say just a word about what the proportionate mortality shows?

Mr. ROGERS. Certainly.

Dr. GILBERT. The error that was reported by Mrs. Tompkins was an error of labeling and not of substance.

I will say also that the table that was noted yesterday by Dr. Milham was one that presented PMR's which were incorrectly labeled SMR's for specific occupation. If you look closely at that table, you find that the occupations are ordered by the radiation exposure received and that there is no relationship between the PMR's reported and the ordering of occupations by radiation exposure.

In fact, the three most highly exposed occupations have the lowest PMR's for cancer, so I do not feel that table supports a radiation effect.

I would say now that I regard the population-based analyses by far as the most balanced approach. The other analyses were initial cuts for which we wrote drafts but now we have carried out the population analysis, which is what Dr. Milham recommended. Others have also spoken about the superiority of this approach, which did not show a correlation of any type between overall cancer rates or of overall death rates even though, or course, it did show two specific cancers.

Mr. ROGERS. Two specific cancers. How much cancer was attributable to these two—about 11 percent wasn't it?

Dr. GILBERT. As the total?

Mr. ROGERS. No; the two cancers.

Dr. GILBERT. I haven't calculated the percentage. There was a total of about four deaths that would be in excess of what one would expect.

Mr. ROGERS. Out of what group?

Dr. GILBERT. I would have to check those figures. The total number of cancers from most causes, I believe there were about——

Mr. ROGERS. No; what I am asking is: Four excess deaths in how many people?

Dr. GILBERT. We included about 20,000 Hanford workers in our analyses.

Mr. ROGERS. And you had four excess deaths——

Dr. GILBERT. That is right.

Mr. ROGERS [continuing]. In your study?

Dr. GILBERT. That is right.

Mr. ROGERS. Who did the first study for Battelle? Did you do it?

Dr. GILBERT. Yes, sir.

Mr. ROGERS. So you did the first and you are now doing the second?

Dr. GILBERT. I guess you could say that.

Mr. ROGERS. Yes. I thought the first study was criticized.

Dr. GILBERT. This was an initial—by whom?

Mr. ROGERS. Well, criticized——

Dr. GILBERT. Was that Mrs. Tompkins?

Mr. ROGERS [continuing]. By Tompkins.

Dr. GILBERT. The only criticism made there was that I incorrectly labeled a table. I apologize for incorrectly labeling a table. But this was a draft report; it was not a report that was written for publication. It was intended that we do a full population-based analysis.

Mr. ROGERS. Her quote is: "It is obvious that the authors"—and I don't know if she knew you were one—"do not understand the meaning or the calculation of common epidemiological terms."

Dr. GILBERT. I would have to disagree with that. If simply mislabeling a table indicates that that is the case, then OK. I don't think simply mislabeling something is an indication that you completely misunderstand it.

Mr. ROGERS. But they said: "Dr. Godbold and I have spent several hours trying to determine exactly what has been done to obtain the data presented in the 1976 document and therefore what interpretation of the data is valid. We cannot."

Dr. GILBERT. Again I say this was a draft.

Mr. ROGERS. I understand.

Dr. GILBERT. It was not written in a way that was to be a complete explanation of what we had done. It was prepared merely for internal use, where I could talk to people and explain it.

Mr. ROGERS. Well, that may be true.

Dr. GILBERT. All right.

Mr. ROGERS. But the results of the quote in which you draw the conclusions from in the study are used?

Dr. GILBERT. Those are not the results from which we were drawing conclusions. This was a preliminary analysis based on the deaths.

Mr. **Rogers**. Now let me ask this, Dr. Liverman: Why was not peer review done of these studies?

Dr. **Liverman**. I believe the topic under discussion has to do with a paper which resulted from research which was carried out, and that is a draft paper; and, as is the normal process in that arena, you may send a paper to a half-dozen of your colleagues for review before you send it out to a peer review journal for publication.

Mr. **Rogers**. No; I am asking why the agency didn't have peer reviews done, like you did on Mancuso?

Dr. **Liverman**. May I ask Dr. Weyzen to respond?

Mr. **Rogers**. Yes.

Dr. **Weyzen**. This particular review by Mrs. Tompkins was requested by me; I received the paper.

Mr. **Rogers**. Maybe then you didn't follow her peer review. You take the peer review that was for the Battelle study and you don't follow it. You give her another study after the peer review said they can't make anything of her initial study; is that what you are saying?

Dr. **Weyzen**. No, sir, that is your interpretation.

Mr. **Rogers**. Then you give me the interpretation.

Dr. **Weyzen**. First of all, I am not quite sure I follow the sequence of peer review or nonpeer review.

Mr. **Rogers**. Obviously somebody doesn't because we have peer review in one place when it satisfies you and we don't in the other when it doesn't. If the reports are coming along, it would appear, with the results that you may like in the agency, then you don't bother with any peer review of the study. But where there is a report that shows something you don't want to be shown, then all of a sudden we are going to have peer review. We are going to call headquarters and have peer review there, and yet we want outside peer review of the other study.

Dr. **Weyzen**. Mr. Chairman, I don't understand how you can make a statement unless you do it in the context of all peer reviews that are being conducted by the division annually, and you will find, with the great number of projects I reviewed—not all of them because——

Mr. **Rogers**. All I asked—and they told me no—is: Did you ever have the two Gilbert studies peer reviewed?

Dr. **Weyzen**. I am quite sure that there must have been a review of the Battelle program before I became responsible for it; I don't know.

Mr. **Rogers**. I am talking about just you.

Dr. **Liverman**. Mr. Chairman, is the question of the initial study or of the paper under consideration?

Mr. **Rogers**. Both.

Dr. **Liverman**. Tell him about the paper; you did have the peer review.

Dr. **Weyzen**. Yes; I sent the paper to Mrs. Tompkins for comment.

Mr. **Rogers**. And yet it was adverse and yet you still let her go ahead and do the whole study.

Dr. **Weyzen**. The explanation was what Dr. Gilbert just said, that this was an initial study; in the meantime they have an additional study of a larger group of people.

Mr. **Rogers**. Why didn't you take it away from her like you did Mancuso, even though his peer review was positive for him?

Dr. **Weyzen**. His peer review was consistent over the years.

Mr. **Rogers**. Not the consensus at all; only one man suggested a change of contractor.

Dr. **Weyzen**. Well, I disagree with you on that, sir.

Mr. **Rogers**. Well, obviously. Why then did you continue the Gilbert study if there was criticism?

Dr. **Weyzen**. Criticism of the study doesn't mean that you have——

Mr. **Rogers**. The review said: Can't make even heads or tails of it. That is pretty heavy criticism.

Dr. **Weyzen**. That is just criticism by one.

Mr. **Rogers**. Of your peer review. Who else peer reviewed the Gilbert stury?

Dr. **Weyzen**. Nobody that I know of.

Mr. **Rogers**. Nobody. All right, let's get to this now. I hope you are listening to this, Mr. Inspector General, because we need some policy changes. I am not sure but what I question the whole concept of allowing the Department of Energy to conduct health research work.

Now let me ask you this, Dr. Weyzen. As I understand it you had decided to give to Oak Ridge Associated Universities the part of the study concerning Oak Ridge workers and decided to give to Battelle the Hanford part of the study. When did you make that judgment?

Dr. **Weyzen**. I believe, sir, that I wrote a memo to Dr. Liverman in September 1977 or August 1977, and informed Oak Ridge Associated Universities and the Hanford Environmental Health Foundation in October 1977. I am not quite sure of the exact date.

Mr. **Rogers**. Could it be October 7, 1977?

Dr. **Weyzen**. That is very possible.

Mr. **Rogers**. Did you have any meetings before you recommended that action——

Dr. **Weyzen**. Yes, sir.

Mr. **Rogers** [continuing]. With any people?

Dr. **Weyzen**. Yes, sir, we had.

Mr. **Rogers**. Did you meet with the Oak Ridge Associated Universities?

Dr. **Weyzen**. Yes, sir. We had two meetings, one with all people that were involved in the data collection system—Hanford, Mound Laboratory, Oak Ridge, National Lead, other people—and there was a second meeting with principal investigators in Oak Ridge at some time, and there was a third meeting in my office several weeks before I wrote this memo.

Mr. **Rogers**. Who do you meet with to determine these things? Is it your staff people or other scientists? I don't know.

Dr. **Weyzen**. I met with all the people that were involved in the study at one point; I met with the principal investigators on a second occasion and a third occasion.

Mr. **Rogers**. Who were involved in these meetings?

Dr. **Weyzen**. From Hanford, Dr. Bryce Breitenstein, who is the director of research at the Hanford Environmental Health Foundation; Dr. Lushbaugh, Oak Ridge Associated Universities; Mrs. Tompkins, at Oak Ridge Associated Universities; a representative from Oak Ridge National Laboratory, that up until recently, handled all the computer data and collection of death certificates; people from the Social Security Administration; practically everybody who was involved in it.

Mr. **ROGERS.** What about industry? Did you have any industry people there?

Dr. **WEYZEN.** What kind?

Mr. **ROGERS.** Nuclear industry people.

Dr. **WEYZEN.** No, sir.

Mr. **ROGERS.** I have a letter of September 12, 1977, with a copy to you evidently from Edythalena Tompkins. It says: To participants in the ERDA health and mortality study, Is this what we are talking about now?

Dr. **WEYZEN.** I believe so, sir.

Mr. **ROGERS.** Robert Jordan, Union Carbide Nuclear Division; Dr. Sidney Marks, Battelle Pacific Northwest Laboratory; Dr. Bryce Breitenstein, Hanford Environmental Health Foundation; Richard Heatherton, National Lead of Ohio; Lynn Denton, Computer Science Division, Union Carbide Nuclear Division; Howard Feuer, Computer Science Division, Union Carbide Nuclear Division; Patrick Adams, Mound Laboratory, Monsanto Research Corporation; C.C. Lushbaugh, Oak Ridge Associated Universities; and William Bibb, ERDA, Oak Ridge Associated Universities.

And it says:

> As we discussed on the telephone, Dr. Walter Weyzen, manager, Human Health Studies Program, DVER, has called a meeting of the participants in the ERDA health and mortality study, aka—also known as—Mancuso project. The meeting will be convened at 9:00, September 27, in conference room 440, Germantown.
>
> The purpose of the meeting is to provide an opportunity for the participants to become acquainted with each other and to learn what the different groups are doing in this study. Each participant should be prepared to give a short informal presentation up to 15 minutes of the activities of their installation relating to the health and mortality study.
>
> It is anticipated that the meeting will be adjourned by 3:00 so people can catch late afternoon planes. Everyone will make their own arrangements.

Now, did Dr. Mancuso attend this?

Dr. **WEYZEN.** No, sir.

Mr. **ROGERS.** Had he been dismissed by then?

Dr. **WEYZEN.** No, sir. If you will go further back in the correspondence, there is a letter from me to Dr. Mancuso—that may have been in 1976; I am not quite sure about the date—explaining to him the complexity of the study and the logistics, the need for orderly transfer of the study and his cooperation in doing that.

Thereupon, I got a message from Dr. Mancusó, and I think it was advising me—that would be in the files—that he would be very, very busy with the conduct of the analysis during the coming year and, for the first 9 or 10 months—I forgot exactly what would be involved—did not have time to spend with us and to design the orderly transfer of the study. And from that point on I did not involve Dr. Mancuso in the deliberations.

Mr. **ROGERS.** Would you let us know what time that was and furnish us those papers, please?

Dr. **WEYZEN.** That is in the files.

Mr. **ROGERS.** Well, if you would let us have the date approximately.

Dr. **WEYZEN.** Yes.

[The following information was received for the record:]

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

October 19, 1976

REVIEW OF ANALYSIS OF HANFORD MORTALITY

Note to J. L. Liverman

On October 4, 1976, Drs. Mancuso, A. Stewart and G. Kneale presented at ERDA, Germantown, their findings of a recent analysis of the Hanford data.

In subsequent discussions with you, Bill Burr and Charlie Edington, it was decided to have an independent review of the material presented to us in view of the potential importance of the results of the analysis.

Drs. Hutchison, MacMahon and Land, and Mr. Jablon agreed to review the data and a tentative date of November 8 was set.

On October 18, I contacted Dr. Mancuso to discuss this review with him. His reaction was almost entirely negative. He did not see the need for a review since a number of experts had already been involved and a review could have been held on October 4, if we had wanted it. He further indicated that a review without Drs. Stewart and Kneale would not be productive since they alone could answer questions on the analysis of the data. If we wanted a review we could have it and invite Stewart and Kneale to return from Manchester to participate. Dr. Mancuso's statements lacked any indication to cooperate in a speedy review of his program.

Assuming that a review of the data by an independent group of experts is imperative, the following options are open to us.

1. Review of the analysis with the aid of the material available, i.e., the tables that were made available on October 4, the abstract of the paper given at the Health Physics meeting, and any other data that can be obtained.

I briefly discussed this option with Drs. Marks and Hutchison and both felt that this probably would be difficult but not impossible. Dr. Marks specifically pointed out that it would be necessary to identify biases in data such as they have found in their analysis.

2. Conduct a review as planned and make arrangements for Dr. Stewart and Mr. Kneale to attend.

There is some question about the practicality of this option, especially if we have to depend on the cooperation of Dr. Mancuso.

3. Independent analysis of the data by a group of outside experts under a contract.

This option would probably require the cooperation of Dr. Mancuso and his staff since the data available to us are incomplete. Duplicates of all data available at Hanford or Oak Ridge will have to be used.

Recommendation

Convene the review group on November 8 to determine

a. What can be done with data available now
b. What additional information would be needed to conduct an independent analysis
c. Where this information can be obtained
d. Have independent review conducted under off-site contract and with guidance of the review group
e. Publication of their findings in the literature.

In this manner, independent outside expertise can advise us on the validity of the conclusions reached by Dr. Mancuso.

Weyzen
Walter H. Weyzen, Deputy Manager
Physical and Technological Programs
Division of Biomedical and Environmental
Research

cc: W. Burr
C. Edington

Walter: I buy the recommendation but suggest the following additional:
1) Carry OGC along with what is being done + record.
2) after data is pulled ask Mancuso to confirm that this is what he has used and if different to pls supply additional data.
JL 10/19/76

AUG 2 3 1976

Dr. Thomas F. Mancuso
Department of Occupational Health
University of Pittsburgh
Graduate School of Public Health
Pittsburgh, Pennsylvania 15213

Dear Dr. Mancuso:

Our Research Committee has approved renewal of your Research Contract entitled "Study of Lifetime Health and Mortality Experience of Employees of ERDA Contractors" for an additional year. The Research Committee decided this should be the terminal year for this contract. Upon completion of this contract, the responsibility for continuation of the Health and Mortality Study will be transferred to the Health Sciences Division of the Oak Ridge Associated Universities (ORAU). To facilitate an orderly transfer we are planning to convene all contractors involved in the Study one or two times during the coming contract year to meet with the technical representative from Headquarters, their consultants and representatives of ORAU. The principal purpose of these meetings is to familiarize thoroughly all parties involved with ongoing research. In addition these meetings will serve to solve any possible problems prior to transfer of the Study. I will contact you in the very near future to discuss these matters in more detail and set a date for the meeting. You will be contacted by someone from the Chicago Operations Office in the near future regarding negotiation of the renewal contract.

At the termination of this contract, please submit a final progress report which includes a detailed summary of your accomplishments during the period of the contract, the number of students trained, the post-doctoral fellows who have worked on the project and the publications which have resulted from the support of your research by the Energy Research and Development Administration.

Sincerely,

Walter H. Weyzen
Deputy Program Manager
Physical and Technological Programs
Division of Biomedical and
Environmental Research

cc: Herschel R. Griffin

bcc: Chicago Operations Office

OFFICE ▶	PIP	PM/BP				
SURNAME ▶	WWeyzen:brb	Carter				
DATE ▶	8/3/76	8/ /76				

Mr. ROGERS. You wrote to Dr. Liverman on October 7, concerning the health and mortality study of workers exposed to ionizing radiation, saying on September 27, 1977, that a meeting was held at Germantown of all participants of the health and mortality study formerly at the University of Pittsburgh. Now, were there any additional people at this meeting referred to in the notice sent by Tompkins that I just read?

Dr. WEYZEN. Additional staff, for instance?

Mr. ROGERS. Additional outside people.

Dr. WEYZEN. I don't believe so, sir; I don't know.

Mr. ROGERS. Why was it necessary to have the Union Carbide people, the lead people and so forth?

Dr. WEYZEN. The list of attendees that you just read with the exception of Dr. Bryce Breitenstein——

Mr. ROGERS. From Oak Ridge?

Dr. WEYZEN. Correct, sir—with the exception of Dr. Bryce Breitenstein and Dr. Lushbaugh, thay were all members of a team which was assembled many years before by Dr. Mancuso and involved in the records collection. So they are essentially his staff.

Mr. ROGERS. What about Dr. Marks? Why was it necessary to have him?

Dr. WEYZEN. Because of Dr. Marks' involvement as an administrative officer of Battelle, his interest in epidemiology, and his consulting with Dr. Gilbert.

Mr. ROGERS. Is it normal to have people that you are going to give a contract to make the determination with you?

Dr. WEYZEN. Sir, we didn't give him a contract.

Mr. ROGERS. This is what you were talking about, isn't it.

Dr. WEYZEN. No, sir, I gave them responsibility to do an analysis with the ongoing contract at the Hanford Environmental Heath Foundation.

Mr. ROGERS. The Hanford health and mortality study— this was in the October 7——

Dr. WEYZEN. Right.

Mr. ROGERS [continuing]. Would be a separate but closely coordinated effort to be conducted jointly by HEHF. What is that?

Dr. WEYZEN. That study was part of the collection office and it was organized under Dr. Mancuso. That was an existing part of the program.

Mr. ROGERS. What I am asking is what is HEHF?

Dr. WEYZEN. It is the Hanford Environmental Health Foundation.

Mr. ROGERS. Is that Battelle?

Dr. WEYZEN. No

Mr. ROGERS. In effect, what is it?

Dr. WEYZEN. I believe it is an independent, commercial business that provides health services for Battelle. Is that correct?

Mr. ROGERS. Is there a contract? Is it a subcontractor of Battelle?

Dr. MARKS. No; it is a contractor to provide occupational health and industrial hygiene services for the entire Hanford plant.

Mr. ROGERS. You do not contract with them?

Dr. MARKS. They do provide such things as physical examinations on Battelle employees, on employees of United Nuclear, Rockwell International and all the other contractors.

Mr. **Rogers**. They just do examinations?

Dr. **Marks**. They do examinations and industrial hygiene measurements and surveys, and they conduct a limited research program which includes a Transuranium Registry. For a number of years they have been collecting data for Dr. Mancuso as part of the health and mortality study.

Dr. **Liverman**. May I clarify, please?

Mr. **Rogers**. Yes.

Dr. **Liverman**. The monitoring of occupational health on our various, different sites is handled in various, different ways. It happens that Hanford does that under contract with the Hanford Environmental Health Foundation. In the case of Oak Ridge the Union Carbide physicians are employed by the company. It differs from site to site, and that is the explanation.

HEHF, in this case are in possession of the medical records for the employees, whereas in Oak Ridge those medical records would be in the control of the Union Carbide Corp., which is the prime contractor. So HEHF in Hanford have the medical reports for all the workers on the Hanford site—Battelle and any other contractors.

Mr. **Rogers**. This says:

> ORAU will submit to BER in the near future a management plan for the health and mortality study. This plan will define the functions and interactions of the various components, such as Oak Ridge, National Lead, Mound Lab, and Union Carbide Computer Center.

Dr. **Weyzen**. Yes, sir.

Mr. **Rogers**. Did you want to comment?

Dr. **Weyzen**. No, sir, sorry.

Mr. **Rogers**. Sorry.

> ORAU has been requested to design and submit for evaluation to BER a plan for simple focus for interaction with the Social Security Administration for treatment of death certificates from the States for all DOE epidemiological studies.
>
> In establishing this office it expects significant dollar savings to be made in the future. HEHF has been requested to submit a design plan.

Now, what did these people have to do with the study that had been done by Mancuso?

Dr. **Weyzen**. The HEHF itself? Dr. Mancuso many years ago assigned to HEHF the responsibility for the data collection for the Mancuso study. The study was then funded out of Washington, out of DOE.

What I am saying in this memo essentially is to redirect the study in the sense of not only giving HEHF the responsibility for collecting records which they have had for 12 years or 10 years but adding responsibility for the analysis.

Mr. **Rogers**. In making the transfer, what peer review group did you rely upon in making the suggestion that it be done by Battelle and by the group at Oak Ridge?

Dr. **Weyzen**. Sir, I was not in the decisionmaking on the transfer to Oak Ridge.

Mr. **Rogers**. Yes.

Dr. **Weyzen**. But I think I know the reasons: There are three. One is a very practical reason: There are enormous advantages in having people work in a place with the data at hand. Under Dr. Mancuso, the records were on one side of the country and the investigator on the other side. We felt there was considerable advantage in having the data onsite; that was part of the decision at Oak Ridge and certainly at Hanford.

Second, there was an existing contract.

Third, at the Hanford Environmental Foundation, several years ago Dr. Bryce Breitenstein joined the staff; he was a physician with training and experience in epidemiology.

Mr. **Rogers**. So, in effect, there was no peer review in making the judgment?

Dr. **Weyzen**. No, sir.

Mr. **Rogers**. Yes. Has there been peer review since?

Dr. **Weyzen**. At Hanford?

Mr. **Rogers**. And at Oak Ridge.

Dr. **Weyzen**. Hanford will be in March; Oak Ridge is not yet planned.

Mr. **Rogers**. It is what?

Dr. **Weyzen**. We haven't made plans for Oak Ridge yet.

Mr. **Rogers**. How long has it been before the peer review, since you gave the contract to Battelle?

Dr. **Weyzen**. The contract was given to the Hanford Environmental Health Foundation by October 1977. And peer review——

Mr. **Rogers**. Did they submit a protocol at that time?

Dr. **Weyzen**. No; they are going to submit a protocol.

Mr. **Rogers**. Pardon?

Dr. **Weyzen**. To explain, there is not a system of protocols; the laboratories submitting a research plan—a 189, it is called. Such a 189 will come in from Battelle.

Mr. **Rogers**. But it hasn't come in?

Dr. **Weyzen**. Hasn't come in yet.

Mr. **Rogers**. In other words, you have already given them a contract?

Dr. **Weyzen**. No; I haven't given them a contract.

Mr. **Rogers**. So they don't know yet about the contract?

Dr. **Weyzen**. I have redirected the research under the existing contract.

Mr. **Rogers**. So that is already an established fact——

Dr. **Weyzen**. Correct.

Mr. **Rogers** [continuing]. Without any peer review to know how they could conduct it?

Dr. **Weyzen**. Sir, I feel very comfortable that we can do without it because I know the quality of the people involved in it.

Mr. **Rogers**. But they have never before studied humans?

Dr. **Weyzen**. Sir, I interact with people at Hanford, on a weekly basis on technical and scientific matters. I think I can trust my judgment in knowing what the people can do.

Mr. **Rogers**. Then you are telling me we don't ever need peer review?

Dr. **Weyzen**. That is not what I am saying. It is your statement, sir.

Mr. **Rogers**. But it is a pretty logical conclusion, sir, if you say you can make all the judgments that everybody else uses peer review to do.

Well, I think there will be other matters we will want to go into later. I would hope, Dr. Liverman, that you will look at this to see if this contract ought to be renegotiated with Dr. Mancuso, because the information evidently given you—and I notice in a press briefing, on the Mancuso-Milham studies, conducted by Dr. Sidney Marks and Dr. Ethel Gilbert November 17, 1977—they are still saying—and this was also in the press conference in March of 1975—"Dr. Mancuso was given advance notice of the termination of his ERDA contract to be effective July 31, 1977, because of unfavorable peer reivews and a need to respond to the Congress and the public on the health of the workers."

Mr. **Carter**. Mr. Chairman, what was the date of that?

Mr. **Rogers**. That is November 17, 1977.

Mr. **Carter**. And——

Mr. **Rogers**. This was evidently a press conference conducted by Dr. Marks and Dr. Gilbert, Battelle Northwest.

Mr. **Carter**. And Dr. Marks had spent only 5 percent of his time on this work? I believe that is what he——

Mr. **Rogers**. I am not sure.

Mr. **Carter**. That is what he said.

Dr. **Marks**. Mr. Carter——

Mr. **Rogers**. Yes.

Dr. **Marks**. I said that I have spent about 5 percent of my time until a great deal of public interest was focused on this issue in November; and, since then, because of the press, public, and congressional interest, I have spent a great deal of time on this matter.

Mr. **Carter**. You didn't tell us that a while ago, though, did you?

Dr. **Marks**. I did, sir.

Mr. **Carter**. I thought you said 5 percent before and now you say a great deal of your time.

Dr. **Marks**. Only since——

Mr. **Carter**. Would that be 100 percent of your available time?

Dr. **Marks**. No, sir.

Mr. **Carter**. What percent of your time have you spent on the Mancuso project since you made this press release with Dr. Gilbert?

Dr. **Marks**. I would guess about 60 percent of my time.

Mr. **Carter**. All right; there is a great difference between the 60 percent which you admit now and the 5 percent which you stated a while ago; isn't there?

Dr. **Marks**. The 5 percent, though, sir, was the period before the public controversy developed.

Mr. **Carter**. Yes; It seems to me, Doctor, that according to the information we have the reputation of a very respectable epidemiologist has been jeopardized by your actions. We have evidence to the effect that his work is indeed reputable according to renowned scientists.

Thank you, Mr. Chairman.

Mr. **Rogers**. May I ask the Inspector General——

Mr. **Seltzer**. Yes, sir.

Mr. **Rogers** [continuing]. Have you had interviews with Dr. Liverman, Dr. Weyzen, Dr. Marks?

Mr. **Seltzer**. Yes, sir.

Mr. **Rogers**. With Dr. Gilbert?

Mr. SELTZER. Yes, sir. We have interviewed, Mr. Chairman, 27 individuals in connection with this investigation, and those that you just listed are included among them.

Mr. ROGERS. Were you aware that the peer reviews were not negative?

Mr. SELTZER. Sir, at this stage of the game the details that have surfaced during your hearings were not familiar to me until I appeared here. Our method of operation is such that I assign two investigators to a case and let them work independently; I wouldn't be getting together with them for subsequent discussions until sometime next week.

Mr. ROGERS. Yes; and, if we may, I would like to have furnished to the committee the original draft of the report and then your final report.

Mr. SELTZER. Yes, sir.

Mr. ROGERS. Now may I also just ask on what basis you assigned the contract to the Oak Ridge Associated Universities and to those particular people—Tompkins and Lushbaugh, I believe.

Dr. LIVERMAN. The contract is with the Oak Ridge Associated Universities through its executive director, and we expect these institutions to provide the investigators.

It turns out in this case, as certainly your record fully reflects, that Dr. Lushbaugh and Dr. Tompkins, both of whom are here and who are scheduled to testify later—at least one of them—on this matter———

Mr. ROGERS. I presume that was also true with Mancuso. Wasn't the contract given to Pittsburgh? Is that what you are telling me?

Dr. LIVERMAN. No; the issue with Dr. Mancuso in Pittsburgh is different, as I tried to explain in my opening comment this morning. In the case of a university professor, the individual who is ultimately going to do the work is the one who submits the proposal.

I know that Dr. Lushbaugh was there, an M.D. who has been involved in this area of activity a long time. But I do not remember whether Dr. Tompkins was or was not there, or who she was employed by.

Dr. WEYZEN. Well, I have to apologize, really, because at that time I was not responsible for the studies; I was responsible for an entirely different program, so I will have to make some guesses.

Mr. ROGERS. Well, now just a minute. I understood that memos we read were from you.

Dr. WEYZEN. I misunderstood. I thought you were talking about the initial assignment of Oak Ridge to conduct those studies, several years ago.

Mr. ROGERS. Well, I thought you had just handled the letting of the contract; the reassignment of the contract on the Mancuso study?

Dr. WEYZEN. Yes, sir.

Mr. ROGERS. Didn't you do that?

Dr. WEYZEN. No, sir, that was done before I had responsibility for the program.

Mr. ROGERS. By Dr. Marks.

Dr. WEYZEN. By Dr. Marks.

Mr. **Rogers**. What has just been done, you did after your meeting that was called and a notice given by Mrs. Tompkins?

Dr. **Weyzen**. There was a considerable amount of discussion whether Oak Ridge should do all of the studies, meaning the Oak Ridge workers and the Hanford workers. At that meeting I made the decision that the Hanford workers study should stay where it is and Oak Ridge should be done at Oak Ridge. That's what I did; because the contract was already in effect, I redirected the programs.

Mr. **Rogers**. Now, who actually assigned the contract in the Mancuso study? It has been divided; who made that judgment?

Dr. **Weyzen**. That was my judgment.

Mr. **Carter**. Who made the judgment to use the two people?

Dr. **Weyzen**. I did, sir.

Mr. **Carter**. Or are now doing it?

Dr. **Weyzen**. I did, sir.

Mr. **Carter**. I thought so.

Dr. **Weyzen**. But let me add one thing.

Mr. **Rogers**. Yes.

Dr. **Weyzen**. Again the initial decision to transfer the study was made in 1975.

Mr. **Rogers**. The decision to get rid of Mancuso was not yours?

Dr. **Weyzen**. No; the decision to transfer the whole study to Oak Ridge Associated Universities was made in 1975, 1976.

Mr. **Rogers**. But it was never done; was it?

Dr. **Weyzen**. It could not be done until the contract was terminated.

Mr. **Rogers**. So the transfer was never carried out; was it?

Dr. **Weyzen**. I am afraid I don't understand you.

Dr. **Liverman**. Let me see if I can clarify.

Mr. **Rogers**. Did you ever transfer the Mancuso contract to Oak Ridge completely?

Dr. **Liverman**. The Mancuso contract terminated on July 31, I believe, this year. There were discussions in the record——

Mr. **Rogers**. 1977; wasn't it?

Dr. **Liverman**. 1977; yes, sir, that is correct. The decision originally to transfer the program to Oak Ridge would have been made at about the same time the decision was made to terminate the Mancuso contract.

Mr. **Rogers**. But actually, that desicion was made before that time, we have that on the record.

Dr. **Liverman**. Yes, right.

Mr. **Rogers**. You had already made that decision; there was a coverup after that. It says so in your records. You even have to contact people in a clandestine manner—Dr. Marks, read it.

Dr. **Liverman**. Yes, I recall the record. I don't understand the implications from the decision which I made.

Mr. **Rogers**. Yes; I understand, but go ahead.

Dr. **Liverman**. The decision to initiate the study in the Oak Ridge Associated Universities was made by me on the recommendations of the staff of the record of——

Mr. **Rogers**. Of what staff?

Dr. **Liverman**. Of the staff of the Department of Energy.

Mr. **Rogers**. Who? You know, that's faceless. Was it Dr. Marks? It wasn't Marks; he had gone, hadn't he, by 1977?

Dr. **Liverman**. The research came—well, the decision to move it there, however, had been made in 1974 or 1975, at the same time the decision had been made to terminate the Mancuso contract—to utilize the Oak Ridge Associated Universities.

Mr. **Rogers**. So it was on Dr. Marks recommendation?

Dr. **Liverman**. Dr. Marks and the research committee.

Mr. **Rogers**. I would like you to furnish for the record the names of the remainder of the staff.

Dr. **Liverman**. All right.

[The information requested was not supplied by the Department at the time of printing.]

Mr. **Rogers**. The staff who advised you on these judgments?

Dr. **Liverman**. Yes.

Mr. **Rogers**. Were you on the staff then, Dr. Weyzen?

Dr. **Weyzen**. Yes, sir.

Mr. **Rogers**. So you contributed to that staff recommendation?

Dr. **Weyzen**. Yes, sir.

Mr. **Rogers**. What was that recommendation?

Dr. **Liverman**. The recommendation was to consolidate the eight or nine studies established at various places in the Oak Ridge Associated Universities and to set over it a suitable advisory committee to insure its integrity.

Mr. **Rogers**. Do we have that in our files?

Dr. **Liverman**. Yes, sir.

Mr. **Rogers**. All right. Now, that decision was made about the same time a judgment was made.

Dr. **Liverman**. Yes, sir.

Mr. **Rogers**. Now, that has never been carried out; is that correct?

Dr. **Liverman**. It was in the process of being put in a position to be carried out; I believe Dr. Tompkins was hired by the Oak Ridge Associated Universities sometime between that 1974-75 decision and this past fall. But I don't know the specifics. But I believe she was not at Oak Ridge Associated Universities at the time that decision was made.

Now, if the record shows that that's not——

Mr. **Rogers**. Yes; but who had she worked for previously; do you know?

Dr. **Liverman**. That I do not know.

Mr. **Rogers**. Excuse me.

Dr. **Weyzen**. Environmental Protection Agency.

Mr. **Rogers**. The Environmental Protection Agency.

Dr. **Weyzen**. Yes.

Mr. **Rogers**. And then went to Oak Ridge Associated Universities.

Dr. **Weyzen**. Yes, sir.

Mr. **Rogers**. Now, since that was never carried out——

Dr. **Weyzen**. Sir, what was never carried out? I am not quite clear on that.

Mr. **Rogers**. Transferring it all to Oak Ridge.

Dr. **Weyzen**. There are two points, one is transferring responsibility for doing it, and the other is transfer of a program.

Mr. **Rogers**. Well, you said Mrs. Tompkins wasn't even there. These are persons that are going to do your work, and it was never even there.

Dr. **Weyzen**. Sir, it wasn't planned to transfer the study until Dr. Mancuso terminated on July 31.

Mr. **Rogers**. All right, was it transferred on July 31 to Oak Ridge?

Dr. **Weyzen**. Yes, sir.

Mr. **Rogers**. Completely.

Dr. **Weyzen**. Yes, sir.

Mr. **Rogers**. Did they do any work on it?

Dr. **Weyzen**. Yes, sir.

Mr. **Rogers**. What did they do?

Dr. **Weyzen**. They are in the process of defining their data base.

Mr. **Rogers**. What about the Hanford?

Dr. **Weyzen**. You would have to ask Mrs. Tompkins; I don't know.

Mr. **Rogers**. Did you transfer the Hanford study to them, too?

Dr. **Weyzen**. Initially the intent was to transfer the——

Mr. **Rogers**. I am not asking about intent. I want a simple answer; yes or no.

Dr. **Weyzen**. Yes.

Mr. **Rogers**. You transferred the Hanford study to Oak Ridge?

Dr. **Weyzen**. Yes.

Mr. **Rogers**. So you transferred it all?

Dr. **Weyzen**. Yes, sir.

Mr. **Rogers**. Now, when did you divide it up again?

Dr. **Weyzen**. I did it in October 1977.

Mr. **Rogers**. All right, so in July you transferred it all, is that right?

Dr. **Weyzen**. Yes, sir.

Mr. **Rogers**. All right, when; in September, October?

Dr. **Weyzen**. Yes, sir.

Mr. **Rogers**. You reassigned the Hanford study to Battelle?

Dr. **Weyzen**. Right.

Mr. **Rogers**. And at that meeting, contractors were present who benefit from how the study would be divided, including Dr. Marks, from Battelle, Tompkins from Oak Ridge. But there was no peer review, is that correct?

Dr. **Weyzen**. That is correct, sir, yes.

Mr. **Rogers**. All right.

Now, what are the qualifications of Mrs. Tompkins and Lushbaugh that made you decide to have them carry out the study, Dr. Weyzen?

Dr. **Weyzen**. Sir, I did not make the judgment to transfer.

Mr. **Rogers**. Well, then, the only judgment you made was to transfer to Battelle the Hanford study?

Dr. **Weyzen**. Correct.

Mr. **Rogers**. Is that what you are telling me?

Dr. **Weyzen**. Correct.

Mr. **Rogers**. But you allowed the Oak Ridge group to continue with the remainder of the study?

Dr. **Weyzen**. Yes.

Mr. Rogers. So you deny making the basic judgment to have them participate?

Dr. Weyzen. Correct.

Mr. Rogers. Who made that decision, Dr. Marks?

Dr. Weyzen. The recommendations were made by the research committee.

Mr. Rogers. Who was on this committee?

Dr. Weyzen. The names of the people involved you will find on——

Mr. Rogers. Was that research committee all called together?

Dr. Weyzen. Yes, the research committee was made up of the entire staff of the division. The names you find on that January 8 memo are the ones who were specifically asked to comment on the recommendations for that particular project.

Mr. Rogers. Did you give us those names, Dr. Marks, do you remember?

Dr. Marks. I don't remember the names.

Mr. Rogers. How many were there involved?

Dr. Marks. May I point out my belief that the research committee consideration of this matter dealt with the renewal of Dr. Mancuso's contract for the period from July 31, 1975, to August 1, 1976.

Mr. Rogers. And who was that?

Dr. Marks. For the participants in the research committee meeting, we would have to consult the records of the organization.

Mr. Rogers. Do we have those records?

Dr. Weyzen. Yes, sir.

Dr. Marks. Yes.

Mr. Rogers. Have you an idea of about how many would be involved? Five, ten, seven?

Dr. Marks. I would guess about 15 to 20 people.

Mr. Rogers. Fifteen, twenty. And were they all agency people?

Dr. Marks. Yes.

Mr. Rogers. None from the outside?

Dr. Marks. Correct. However, we did have two reviews by outside reviewers of the proposal in advance of the meeting. Their recommendations were discussed at the meeting, although they were not present, and were considered in the deliberations.

Mr. Rogers. Who were the outside reviewers?

Dr. Marks. Because of the peer review system, I would not submit their names.

Mr. Rogers. Could you furnish us copies? We don't find copies of that.

Dr. Marks. I think they should be there.

Dr. Liverman. You have those. It may be difficult to sort out.

Mr. Rogers. Could you give us a date and place that that was done?

Dr. Marks. Their written reviews would be dated August 27 and September 15, 1975.

Mr. Rogers. And where was this held?

Dr. Marks. The date of the actual meeting was January 8, 1976.

Mr. Rogers. All right, and where was that held?

Dr. Marks. It was held in the ERDA headquarters in Germantown.

Mr. **Rogers**. Do you have copies of those?

Staff. I have.

Mr. **Rogers**. All right, he says we have them.

Dr. **Liverman**. Yes.

Mr. **Rogers**. Now, were Mrs. Tompkins——

Dr. **Marks**. I may mention—may I?

Mr. **Rogers**. Certainly.

Dr. **Marks**. I may mention that one of the reviewers stated at the end of July 1976, it is my recommendation that the study be turned over to a different principal investigator and supporting staff since the study could remain an important one, if it were done properly. I quote this from the outside review.

Mr. **Rogers**. Yes.

Mr. **Carter**. And what was the date of that?

Dr. **Marks**. August 27, 1975.

Mr. **Carter**. 1975. Meeting in Germantown was in January 1976.

Dr. **Marks**. Yes, sir.

Mr. **Carter**. What decisions were made there?

Dr. **Marks**. The decision was made to continue the contract until July 31, 1977, in accordance with the assurance that was originally made to Dr. Mancuso in March 1975, that his services would be retained as principal investigator until July 31, 1977.

Mr. **Rogers**. So, let me ask——

Mr. **Carter**. Yes, sir, go right ahead.

Mr. **Rogers** [continuing]. Who made the judgment at that time, when you said the decision was made to transfer the study to Oak Ridge, who did the peer review, who looked at the facilities, who looked at the capabilities of the scientists, and who looked at the chief investigator.

Were you involved in any of these decisions?

Dr. **Marks**. It was a decision, make jointly with the deputy director of the division, associate manager of research and development, and other people in the division who were familiar with the project.

Mr. **Rogers**. In other words, you just assigned it to Oak Ridge Associated Universities not knowing whether they could do it or not?

Dr. **Marks**. There was recognition of the quality of the personnel involved, based on——

Mr. **Rogers**. Who were the personnel involved?

Dr. **Weyzen**. Mr. Chairman, I would like to respond.

Mr. **Rogers**. I thought you said you weren't there?

Dr. **Weyzen**. I was at the time on the staff of the medical branch at that time, sir.

Mr. **Rogers**. Well.

Dr. **Weyzen**. I was at the agency, but——

Mr. **Rogers**. Well, then you didn't make the judgment, if you weren't there, but go ahead and talk.

Dr. **Weyzen**. I think it's important for the committee to know that in 1974, an extensive peer review of the Oak Ridge Associated Universities' program was undertaken with some 15 or 20 reviewers. Recommendations were made to us that Oak Ridge Associated Universities should redirect its program and should assume responsibility for health studies.

And that recommendation was made based on the findings of the review committee and of the available talents in Oak Ridge.

Mr. ROGERS. Do you have those papers?

Dr. WEYZEN. Yes, sir, it's part of the file.

Mr. ROGERS. As of May or March of 1974?

Dr. WEYZEN. At that time, yes.

Mr. ROGERS. Now, what about the investigator? What did you determine there? You said it wasn't your decision, but you seemed to know what happened. Who was the chief investigator of the study?

Dr. WEYZEN. Of what study, sir? Are you talking about the peer reviews of Oak Ridge Associated Universities? We determined that the time had come for another peer review.

Mr. ROGERS. Yes.

Now, what I am asking is when you decided to reassign the study, how did you determine, who would be the chief investigator? Who would be conducting the study? Did you make any determination of that?

Dr. WEYZEN. The principal investigator?

Mr. ROGERS. Yes.

Dr. WEYZEN. The Director of the Medical Health Sciences Division is Dr. Lushbaugh.

Mr. ROGERS. And he was to be the chief investigator?

Dr. WEYZEN. Administratively, he is the chief investigator. The principal investigator of the study is Mrs. Tompkins.

Mr. ROGERS. Was she there at the time?

Dr. WEYZEN. She was not there at the time, but——

Mr. ROGERS. But you thought maybe they might get her, is that right?

Dr. WEYZEN. They might get her?

Mr. ROGERS. Well, who was going to be the chief investigator?

Dr. WEYZEN. He told——

Mr. ROGERS. You didn't even look at that?

Dr. WEYZEN. He told the Oak Ridge Associated Universities they should find a qualified——

Mr. ROGERS. Just go out and find somebody?

Dr. WEYZEN. Find a qualified investigator.

Mr. ROGERS. And what was the extent of this contract overall, the Mancuso contract. How much money has been put into it?

Dr. WEYZEN. I believe about $6 million over 14 years.

Mr. ROGERS. $6 million. And you just tell a group, "You find an investigator." Is that the practice of the office?

Dr. Weyzen.

[No response.]

Mr. ROGERS. Well, I know you weren't in charge then, were you; I forgot that. Is that your practice now?

Dr. WEYZEN. When we feel it necessary, in the interests of the study, to transfer a study, we do it, sir.

Mr. ROGERS. But don't you do it properly, sir? Why don't you do it properly like you do in others?

Dr. WEYZEN. Yes.

Mr. ROGERS. Or maybe you don't. But would you not as a normal practice want to know who the chief investigator is going to be, and something about their competence, when you take it out of the hands of one scientist and give the project to another group?

Dr. **Weyzen**. It's my opinion that if Oak Ridge finds a qualified investigator it is qualified to do it, by definition.

Mr. **Rogers**. It would suit you, no matter whether that person were an epidemiologist or pathologist, or in some other field?

Dr. **Weyzen**. No, when I talk about a qualified investigator, I am talking about an epidemiologist.

Mr. **Rogers**. You don't have an epidemiologist at Baettelle?

Dr. **Weyzen**. Dr. Gilbert is an epidemiologist; she just said so.

Mr. **Rogers**. They have never done studies. They just hired her, isn't that true?

Dr. **Weyzen**. Yes, sir, that's true.

Mr. **Rogers**. So you didn't know the person who was going to be in charge of the study, but you transferred it anyway?

Dr. **Weyzen**. It was transferred, yes, sir.

Mr. **Rogers**. And you did not know who the chief investigator would be?

Dr. **Weyzen**. Certainly I didn't know at that time.

Mr. **Rogers**. Did you, Dr. Marks?

Dr. **Marks**. May I say that the decision to transfer would be contingent upon developing proper staffing. The transfer was not made in March 1975. Discussions were held at that time in anticipation of a transfer on July 31, 1977 if proper staffing were developed.

Mr. **Rogers**. Then you told me before that the judgment was made to transfer the study back them, but you didn't even have a chief investigator. And now you come and divide it up again, where you have Dr. Marks at the meeting who is a beneficiary from his corporation, and you have Lushbaugh, who is also a beneficiary. That group gets together and divides up a study, without any peer review.

Dr. **Marks**. Mr. Chairman, at the meeting in September of 1977?

Mr. **Rogers**. Yes.

Dr. **Marks**. The question of dividing the study did not come up. The session was largely devoted to questions regarding the data base and the manner in which the study will be heard, carried forward in the future.

Mr. **Rogers**. Well, now, I thought Dr. Weyzen told us it was on that basis that he made the judgment for separtating the study.

Dr. **Weyzen**. That is correct, sir.

Mr. **Rogers**. Well, it's hard for us to find out what is happening or what has happened. All I can say is that it's the most disordered—Dr. Liverman.

Dr. **Liverman**. May I comment?

Mr. **Rogers**. Yes. Well, let me comment.

Dr. **Liverman**. Yes.

Mr. **Rogers**. It's the most disordered, unstructured mess that I have looked into in some time. If our research programs are being carried on in this manner, where you just take a study from one scientist and give it to some other group without even knowing who the principal investigator will be or his qualifications, this is a very inefficient, poor way of managing a research program and it is not a competent way to spend tax dollars. We are going to have to go into this in some detail, and I will ask other committees to do so as well. We many also ask the Department of Justice to look into this whole matter. Certainly you may comment.

Dr. LIVERMAN. After your comment, what's left to say?

Mr. ROGERS. Well, I would hope you could say you could take some corrective action, and straighten out a few things.

Dr. LIVERMAN. Well, that I can certainly say.

Mr. ROGERS. Certainly it's unbelievable that decisions which are supposed to be made on some particular basis we find weren't at all. Excuses were still given that those were the bases of decisions made. It's just no way to operate. The Congress has some responsibility to see that taxpayers dollars are spent efficiently and properly.

Dr. LIVERMAN. May I?

Mr. ROGERS. Certainly.

Dr. LIVERMAN. Let me go back to the original decision concerning Dr. Mancuso's contract, which I made and for which I clearly am responsible, since the buck stops with me. On the basis of the information provided me, the decision was made to move the program.

It was felt that there were a number of very practical reasons for centralizing all of the studies, over a period of time, in the Oak Ridge Associated Universities.

Because of changing programs, we should sit down with the management of Oak Ridge Associated Universities to discuss with them the future directions of their programs, namely, to get in to the human health studies areas in a more significant way than they had. One of the issues discussed with the current director and with members of the board was that we wanted to centralize studies relating to exposures of workers. We believed that we would be able to obtain independent judgments without any control on the part of the agency, to dictate, in any manner, those judgments. ORAU would be able to manage a quality program an attract well-qualified people.

In that context, then, we rely upon the Oak Ridge Associated Universities to employ investigatiors.

We are now in the process, as Dr. Weyzen has said, of evaluation before we increase their budget in any regard.

Mr. ROGERS. To increase it?

Dr. LIVERMAN. If they study the total population of those exposed to radiation, the size of the program will be increased.

Mr. ROGERS. Now, who made the judgment that Mrs. Tompkins would be the chief investigator?

Dr. LIVERMAN. I do not know the answer to that.

Mr. ROGERS. Mr. Weyzen?

Dr. WEYZEN. I do not know, sir.

Mr. ROGERS. You didn't?

Dr. WEYZEN. No.

Mr. ROGERS. Did you approve it?

Dr. WEYZEN. I don't believe—in retrospect, I approved it; yes, sir. But at that time I don't think I was in the chain of——

Mr. ROGERS. Well, when did you get into this chain? I thought you were there all along, but you didn't take command, I understand, until when?

Dr. WEYZEN. No; I was not involved in this part of the program. My responsibilities were in the nuclear medicine program.

Mr. ROGERS. But now?

Dr. WEYZEN. I did have responsibility in 1976.

Mr. ROGERS. Well, this did not happen until 1977; did it? I thought you just told me you made the judgment for Oak Ridge to continue the study.

Dr. WEYZEN. I believe you were asking me about the appointment of Tompkins.

Mr. ROGERS. That's exactly right.

Dr. WEYZEN. And that went back several years.

Mr. ROGERS. Well, they told me she had just been recently hired.

Dr. WEYZEN. No; that not so. That's not true.

Mr. ROGERS. She has been there how long, at Oak Ridge?

Dr. WEYZEN. I believe she has been there at least 3 years.

Mr. ROGERS. Three years?

Dr. LIVERMAN. Mr. Chairman, Dr. Lushbaugh, who is director of that program and would have hired Dr. Tompkins, is here and could answer that question.

Mr. ROGERS. All right.

Well, let me ask again, since you still have not answered for me, Dr. Liverman, you or you staff, who was it that approved Mrs. Tompkins as chief investigator?

Dr. LIVERMAN. Well, since the buck stops with me, ultimately it has to be——

Mr. ROGERS. Well, I know, but who really made the judgment? Was it Dr. Marks? Was it Dr. Weyzen, or is there somebody in between that may have made the judgment?

Dr. WEYZEN. I don't know, sir.

Mr. ROGERS. Do you know, Dr. Marks? Or didn't you care about who was the chief investigator? Or is she? Maybe she's not the chief investigator now; is she?

Dr. MARKS. I don't know if Mrs. Tompkins or Dr. Lushbaugh is, would be officially the chief investigator.

Mr. ROGERS. Well, I doubt it if Dr. Lushbaugh could be doing this; could he, as he has some rather heavy administrative duties?

Dr. MARKS. Right, sir.

Mr. ROGERS. I assume you would not approve such a person.

Dr. MARKS. Yes; the consideration of Mrs. Tompkins assuming principal responsibilities for the epidemiology study was discussed during 1975, and Mrs. Tompkins could provide information as to the date of hire, which was——

Mr. ROGERS. But you don't know whether you approved her at that time, while you were in the position of responsibility, or if you would have said she would be the chief investigator?

Dr. MARKS. I would not have made that decision.

Mr. ROGERS. Who would have made that decision? Anybody?

Dr. LIVERMAN. Mr. Chairman, it's clear that I think none of us at this table know the precise details. Could I provide it for the record as fully as we can provide it.

Mr. ROGERS. Could you tell me the person who was in charge of the office to approve it, on your staff? Who was your predecessor, Dr. Weyzen?

Dr. WEYZEN. My predecessor was Dr. Goldstein, who retired.

Mr. ROGERS. So he might have made it?

Dr. WEYZEN. That's very well possible, sir. But I don't know.

Mr. ROGERS. You just don't know? Have you checked who is the chief investigator now?

Dr. WEYZEN. That's Mrs. Tompkins.

Mr. ROGERS. And you approve of that?

Dr. WEYZEN. Yes, sir.

Mr. ROGERS. All right, so it is now your approval, and now your judgment, that she should be the chief investigator?

Dr. WEYZEN. Yes, sir, I said that before.

Mr. ROGERS. Well, that's the first time I have heard that. But we don't know quite who approved or who recommended her?

Dr. WEYZEN. No, sir, I don't.

Mr. ROGERS. Very well.

Dr. LIVERMAN. Let me provide that for the record. I am sure it's in the record that you have, but it's too voluminous to find it easily.

Mr. ROGERS. Yes; if you would.

Dr. LIVERMAN. Thank you.

[The information referred to follows:]

Mrs. Tompkins was selected as chief investigator by Dr. C. C. Lushbaugh.

Mr. ROGERS. Now, let me ask you this, Dr. Liverman, did you prepare your statement, or did you have staff prepare your statement?

Dr. LIVERMAN. In general, the staff prepares these statements.

Mr. ROGERS. Yes, I understand.

Dr. LIVERMAN. Yes, sir, in this case.

Mr. ROGERS. Did you also have your staff prepare your statement for the Inspector General?

Dr. LIVERMAN. My statement for the Inspector General was by direct interview, with no statements in front of me.

Mr. ROGERS. I see. This is a recollection of the Mancuso program.

Dr. LIVERMAN. You are looking at my memo written subsequent to that meeting?

Mr. ROGERS. Yes.

Dr. LIVERMAN. I said this is the way I recall the matters as they arose in that time frame; I did that by my own hand, on my own typewriter.

Mr. ROGERS. And I notice you state a judgment by his scientific peers that the work should be limited, terminated, or another investigator selected to be the principal investigator.

"A clear lack of publications, a reluctance to initiate any analysis until all the data were complete, even though they said it might not have them all." And I guess that is a verbatim statement of——

Dr. LIVERMAN. Yes, sir; it is.

Mr. ROGERS. That's why I wondered if your staff——

Dr. LIVERMAN. No; not the staff, I did that myself, based on my recollections of everything that happened. It could be erroneous, but it's my belief.

Mr. ROGERS. Yes; there is a vote. Dr. Liverman, I would like for you to submit to the committee your proposed actions of what you plan to do since we have gone into this matter, what corrective actions you can take, what actions you can take about the staff that misinformed you, what you would do on the contract concerning the Mancuso investigation. I would also like your recommendations as to whether there should be in-house studies on a matter as sensitive as this.

I would appreciate your furnishing the committee with this within a week, if you could.

Dr. **Liverman.** If I could have a little more time?

Mr. **Rogers.** Ten days.

Dr. **Liverman.** I have extensive authorization hearings next week.

Mr. **Rogers.** Yes, sir, we will try to cooperate with you.

Dr. **Liverman.** I will work with your staff on this issue.

Mr. **Rogers.** All right now, if you would let us have your report, Mr. Inspector General, as soon as possible, the original draft and the final draft.

Also we may have to call you back and we will be in touch on that. We appreciate your patience with the committee, and thank you for being here.

We will not go into further matters at this time because we have other witnesses waiting so we will have to call you back and arrange a time.

Dr. **Liverman.** Am I free to go today?

Mr. **Rogers.** Certainly.

Dr. **Liverman.** Thank you.

Mr. **Rogers.** And thank you for the others presence here as well, and, Dr. Marks, thank you for being here.

Dr. **Marks.** Thank you.

Mr. **Rogers.** Thank you.

Dr. **Liverman.** Thank you.

We will recess until 2 p.m.

[Whereupon at 1:15 p.m. a recess was taken to reconvene at 2 p.m. the same day.]

AFTER RECESS

[The subcommittee reconvened at 2:30 p.m., Hon. Paul G. Rogers presiding.]

Mr. **Rogers.** The subcommittee will come to order, please.

Our next witnesses will be Dr. Edythalena Tompkins, chief epidemiologist, and Dr. C. C. Lushbaugh, chief of the medical health services, medical division, Oak Ridge Associated Universities.

We welcome you to the committee. We appreciate your presence. The committee will be pleased to receive any comments you may decide to make.

STATEMENTS OF C. C. LUSHBAUGH, M.D., PH. D., CHIEF, MEDICAL HEALTH SERVICES, MEDICAL DIVISION, OAK RIDGE ASSOCIATED UNIVERSITIES, ACCOMPANIED BY EDYTHALENA TOMPKINS, CHIEF EPIDEMIOLOGIST, MEDICAL DIVISION, OAK RIDGE ASSOCIATED UNIVERSITIES; AND PAUL TOMPKINS, FORMER EXECUTIVE DIRECTOR, FEDERAL RADIATION COUNCIL

Dr. **Lushbaugh.** My name is Clarence Lushbaugh. I am a physician trained at the University of Chicago, trained in pathology with a Ph. D. in that field. I have worked at three institutions in my lifetime: University of Chicago for 11 years; Los Alamos Scientific Laboratory, where I was head of experimental pathology and also chief of laboratories at the Los Alamos Medical Center Hospital for 15 years; the Oak Ridge Associated Universities where I went in 1963. At ORAU I became principal investigator for a special study for the NASA manned space program where we were trying to establish human radio biological data. We studied masses of clinical data from irradiated persons and patients, trying to establish safe career doses for astronauts.

This program went on for about 10 years and gave us some expertise in the handling of large masses of data. This, I think, was one of the reasons for ERDA selecting us as one of the outfits that might be able to carry on the health and mortality program.

I think that Dr. Hutchins yesterday said it very well when he said that one of the problems with the kind of program that we are discussing here today is finding a group of persons who will deal with large amounts of very complicated data that takes long years to develop and to publish the results; and that the real problem is that most universities and university staffs where they have the publish-or-perish burden on their backs can't really afford to do this kind of work. So ERDA and other establishments need to have laboratories that can do this kind of task. This is the sort of thing that Oak Ridge Associated Universities has pioneered in since 1946.

It is also a fact that the Oak Ridge Associated Universities differs from most of the in-house ERDA laboratories in that it is under the direction of a board of directors which is elected by a council of representatives from the 45 sponsoring universities. These councilmen actually come and give us peer overview on a yearly basis and select their own medical review committees.

We have another peer review committee in addition to that from those universities. This scientific peer review committee reviews the medical sciences programs, also on an annual basis. This is a committee made up of a five academicians. Dr. William Stone, from the University of Wisconsin, is the head of our scientific peer review committee. We have Dr. George Hutchins, who is here as a witness before your committee as a member of our peer review committee. He is our epidemiologist on this committee.

I became the medical staff chief at ORAU in the spring of 1975 and became the permanent chairman in the summer of 1975. I was told about the imminent changes that were being considered in the health and mortality program by the Government. One of the programs that seemed to fit our expertise was the establishment of a radiation emergency assistance center and training site (REAC/TS). I was put in charge of developing this program. It was a 2½-year effort on my part to establish REAC/TS.

One of the programs in the REAC/TS program was the establishment of a study to follow up all the persons who had been involved inadvertently in radiation overexposures in the United States. So this is a clinical epidemiological program that I am in charge of.

So when the events occurred that you have heard, I was told to search around for somebody with stature who could carry on this program for me. Because although pathologists think they are epidemiologists, they really are not. I am a clinical epidemiologist wise enough to realize the need for a real epidemiologist. So, consulting my peers, many of whom are on the BEIR Committee, and looking for somebody with a reputation to handle masses of data, I found there was a Mrs. Tompkins, then working for EPA, who had plans of changing her situation. She had been at HEW/BRH. She was in charge of radiological epidemiological programs for EPA; had started in that position in 1970. Previously, she had entered radiation epidemiology in 1962 at the Bureau of Radiological Health, where she conducted the studies on thyrotoxicosis. When the Bureau relinquished its responsibilities for the control of radiation in the environment to EPA, she transferred to the EPA and was placed in charge of its radiological epidemiological program. She came very well recommended to me by such persons as Dr. John Storer, Dr. Victor Bond, Dr. Saenger, and Dr. Telles, and I could go down the line.

I got no bad vibes on this. In the usual situation when you are given program guidance and told you are going to be in charge of a program, you are expected to acquire staff, find a principal investigator who can stand the heat and do the work. You present your proposals and you begin.

So, in the summer of 1975, I began talking with Mrs. Tompkins. In late 1975, we had worked out a plan and she came onboard in May, I believe, 1976. The idea was that she would be on the staff and working with the program in order to have an orderly transitional period and the so-called Mancuso project would be gradually phased into our activities. When the transitional period was over on July 31, 1977, we took over the responsibility for the operation of the ERDA health and mortality study under Mrs. Tompkins' guidance.

Mr. ROGERS. Thank you.

Mrs. Tompkins.

Mrs. TOMPKINS. I think Dr. Lushbaugh covered everything, Mr. Rogers.

Mr. ROGERS. All right. We may have a few questions.

Dr. Carter.

Mr. CARTER. What is your view on the health risks of exposure to low-level ionizing radiation?

Dr. LUSHBAUGH. Are you asking me?

Mr. CARTER. Yes.

Dr. LUSHBAUGH. I think that exposure to radiation is a risk. I think it is a risk at all levels. My special expertise, however, has been in evaluating risks from the high doses of radiation. I am not an expert in low-level radiation. In late effects I am only experienced insofar as I direct our followup program of radiation accident victims, most of whom have been exposed to rather substantial doses.

Mr. CARTER. What would happen to a person exposed to 500 rem of radiation?

Dr. LUSHBAUGH. That is a little more than the LD-50 for man. Without good clinical support, it would be a one out of two chances of his getting a fatal——

Mr. CARTER. Do you think he would have one out of two chances?

Dr. LUSHBAUGH. Right.

Mr. **Carter**. What about 300 rem?

Dr. **Lushbaugh**. If you are speaking of bone marrow doses? This is 1 bone marrow dose of 300 rem within 1 week?

Mr. **Carter**. I am speaking of a whole body dose, not to particular bone marrow.

Dr. **Lushbaugh**. A person so exposed, would, I would say, have a pretty fair chance of surviving if he had good, clean, supportive medical care.

Mr. **Carter**. What are the symptoms of radiation sickness, say from a dose of 100 rem?

Dr. **Lushbaugh**. At that dose, you usually lose your appetite. This is followed by nausea and then you may or may not have vomiting. At about 200 rad or rem, 1 out of 2 persons will vomit. At the dose you suggested (100 rem) there is a lesser probability of going so far as vomitting.

Mr. **Carter**. What about nosebleed?

Dr. **Lushbaugh**. Nosebleed occurs in the so-called agranulocytic angina that occurs with radiation exposure at the lethal level. It is one of the signs we saw in the Hiroshima-Nagasaki persons. It was used as one of the very important end points to decide whether a person had received a significant dose.

Mr. **Carter**. We saw that also in "Smoky." What research have you done with respect to the question of the effects of the health risk of ionizing radiation?

Dr. **Lushbaugh**. I am an expert in large doses of radiation and their late effects. I was trying to determine in our NASA studies whether or not man would be able to repair a dose of radiation to his bone marrow that occurred in an 8-day period. My focus at that time, again on an in-house project for NASA, was the Moon trip up to the Moon and back. This was supposed to involve a week to 8 days. The question was, if one was going to get a small dose of radiation during that time, do we use single exposure data as our criteria to predict the damage that man was going to have to repair. So we examined some 3,000 medical records of persons with various kinds of leukemias that received radiation in order to treat their diseases to see whether or not protracted or fractionated radiation was reacted to differently by the marrow or not. We found that man does not repair bone marrow damage in a week, but in that time frame he does repair the damage that causes him to have nausea and vomiting.

Mr. **Carter**. He does not repair the bone marrow in a week?

Dr. **Lushbaugh**. Not in 1 week. It was my specific task to discover that.

Mr. **Carter**. What was the second?

Dr. **Lushbaugh**. Even though he did not repair the damage to his marrow, somehow or other he did repair his damage to the gastrointestinal apparatus which caused him to have nausea and vomiting.

Mr. **Carter**. What research have you done in this area, Dr. Tompkins?

Mrs. **Tompkins**. My primary work in this area was with the Bureau of Radiological Health starting in 1962, when I joined the study which had just started on the long-term followup of individuals who had been treated for hyperthyroidism, people who had been treated with radiation, people who had been treated with surgery, and people who had been treated with drugs.

Mr. **Carter.** Iodine-131?

Mrs. **Tompkins.** Yes.

I became director of the program and continued as director of the program until the final writeup in 1972.

Mr. **Carter.** What were your findings?

Mrs. **Tompkins.** The study was designed to test for an increased risk of leukemia in patients treated with radioactive iodine, as compared with patients who were not treated for the same disease, without radioactivity. We found no increased risk of leukemia in the population we studied.

Mr. **Carter.** With radioactive iodine?

Mrs. **Tompkins.** That is right.

Mr. **Carter.** How many cases did you check?

Mrs. **Tompkins.** 22,000.

Mr. **Carter.** In the cases treated with iodine-131, you found no increase of any type of cancerous tumor?

Mrs. **Tompkins.** I am sorry, that is not true. We only looked at leukemia. That was what the study was designed to test.

Mr. **Carter.** You found it did not cause leukemia; is that what you are saying?

Mrs. **Tompkins.** Yes.

Mr. **Carter.** I will accept that.

Mrs. **Tompkins.** Wait a minute. We did not say it did not cause leukemia. We said in the population we investigated, we saw no increased risk.

Mr. **Carter.** Of leukemia?

Mrs. **Tompkins.** Correct.

Mr. **Carter.** Did you find any increased risk of any other cancer?

Mrs. **Tompkins.** We published an observational paper on the findings on thyroid cancer. The study was not designed to test for an increased risk of thyroid cancer. We could not talk about thyroid cancer in terms of risk.

Mr. **Carter.** I did not understand. Will you speak just a little louder into the mike.

Mrs. **Tompkins.** We published an observational paper on the findings on thyroid cancer ~~in this~~ population. The study was not designed to test the hypothesis of an increased risk of thyroid cancer and no risk assessment was made.

Mr. **Carter.** Are you aware of the study involved in the children of Rongelap Islanders?

Mrs. **Tompkins.** Yes; I am.

Mr. **Carter.** These 19 children received an estimated dose of 500 to 1,400 rad from the iodine-131 in the fallout.

Mrs. **Tompkins.** Th~~at is righ~~t.

Mr. **Carter.** You know these doses are well within the range of some thyroid procedures that have been used in the United States?

Mrs. **Tompkins.** That is correct.

Mr. **Carter.** I believe that 17 of these children receiving iodine-131 in fallout developed thyroid lesions which were surgically removed. Two of them were dwarfed for life. What comment do you have on this study, Dr. Tompkins?

Mrs. **Tompkins.** Those are the findings of the study.

Mr. CARTER. Pardon?

Mrs. TOMPKINS. Those are the findings of the study.

What kind of comment do you want?

Mr. CARTER. The study of the Rongelap children appears to contradict the findings of your study. How long was your followup study?

Mrs. TOMPKINS. The first patients were treated in 1946 when iodine-131 became available. The last patients enrolled in the study were treated in 1964. They were all followed to 1968.

Mr. CARTER. Was this long enough for the incubation period for leukemia?

Mrs. TOMPKINS. Yes, sir, it was.

Mr. CARTER. Do you believe there is a safe level of exposure to ionizing radiation?

Mrs. TOMPKINS. No, sir.

Mr. CARTER. How do you account for your findings then if you knew ionizing radiation or iodine-131 has no bad effects?

Mrs. TOMPKINS. Sir, I did not say there were no bad effects. I did a research study. The findings were as they were. I could not create cases of leukemia and I could not subtract them. That is what the study found.

Mr. CARTER. During your husband's tenure as Executive Director of the Federal Radiation Council, were the standards changed?

Mrs. TOMPKINS. I don't know.

Mr. CARTER. I believe they were increased 20 times upward of the amount of radioactivity that would be permitted in the environment in the event of a leak from an underground test or from an accidental release from a nuclear reactor. Do you disagree?

Mrs. TOMPKINS. I have no knowledge, sir.

Mr. CARTER. What are your current research responsibilities?

Mrs. TOMPKINS. Developing an epidemiology program at Oak Ridge Associated Universities.

Mr. CARTER. If the Mancuso findings are correct, what implications would that have for your own research and your own views on the risks of low-level radiation?

Mrs. TOMPKINS. I don't know that it would affect my own research at all.

Mr. CARTER. Ma'am?

Mrs. TOMPKINS. The research method, sir, is to repeat in different populations under different exposure situations studies to determine consistency. Certainly you would want to look at the Oak Ridge population to determine if it had the same findings as those which have been suggested for the Hanford population.

Mr. CARTER. You have been at Oak Ridge now how long?

Mrs. TOMPKINS. Since May of 1976.

Mr. CARTER. What have been you duties since you have been there?

Mrs. TOMPKINS. To establish an epidemiology program.

Mr. CARTER. To establish it?

Mrs. TOMPKINS. Yes.

Mr. CARTER. Has it been established?

Mrs. TOMPKINS. I believe it is well on its way, yes.

Mr. CARTER. When did it get well on its way?

Mrs. TOMPKINS. We have just completed our first study which has been underway over the past year.

Mr. CARTER. You have completed your first study?

Mrs. TOMPKINS. Yes.

Mr. CARTER. Your findings were negative?

Mrs. TOMPKINS. They happened to be negative, yes, sir.

Mr. CARTER. I expect that had exactly——

Mrs. TOMPKINS. It was not a study of radiation, sir.

Mr. CARTER. Thank you, Mr. Chairman.

Dr. LUSHBAUGH. That study was a study on nickel workers.

Mr. ROGERS. Let me ask this, if I may. How many people would you say are employed at Oak Ridge Associated Universities?

Dr. LUSHBAUGH. There are approximately 350 employees in that institution. There are 80 on my staff.

Mr. ROGERS. And what are your particular duties now?

Dr. LUSHBAUGH. Chairman of the Medical Health Sciences Division where we have five major programs.

Mr. ROGERS. You are funded how?

Dr. LUSHBAUGH. One-third of our funds come from NIH, American Cancer Society, Damon Runyon funds, et cetera, and two-thirds of our funds come through a contract with DOE.

Mr. CARTER. What are the studies you are doing on cancer for the Damon Runyon Fund?

Dr. LUSHBAUGH. One of these studies is lipid biochemistry, another is thrombocytopenic purpura. We also have a study in biochemistry which investigates the way various analogues can be put into cell membranes that alter the cell's resistance to the various kinds of carcinogens coming from the coal liquefaction process and effluents of that sort. We have a cytogenetic study of sister chromatid exchanges in persons who are exposed to radiation and coke oven workers who were exposed to large levels of PNA's.

Mr. CARTER. What are main studies for the cancer fund?

Dr. LUSHBAUGH. We also have one concerned with colon cancer on marmosets. We have one of the three research colonies of marmoset monkeys in the United States.

Mr. CARTER. What about human epidemiological studies of the health effects of radiation?

Dr. LUSHBAUGH. One that I call a clinical epidemiological study, is a followup program we do in conjunction with NRC of all persons who are involved in radiation incidents and radiation accidents, so that we identify these persons, find out where they are and we continue their long-range study as long as we can. Some of these persons were enlisted in the program by an accident that occurred in 1945. We followed some of those persons who were still in the program 30 years following their survival.

Mr. ROGERS. Were any affected by low-level or high-level radiation, that you looked at?

Dr. LUSHBAUGH. In some of these accidents, the high-level persons died in the accident. The low-exposure persons are the ones who have survived since that time. Some of those persons have now just begun to be ill. One of them was 57 in 1945. He died at age 87, last year in Illinois. I don't know whether he had any life shortening. Perhaps he did. But he didn't die of any acute effects. He is the oldest man that we have in the program and the individual who survived the longest.

Mr. CARTER. Who is the youngest?

Dr. LUSHBAUGH. Another young man in the accident who preceded him came to light several years ago in Columbus, Ohio, with an acute myelogenous leukemia. You might be interested to know that when we sent our cytogenetic team to review his case, we found he still had persistent chromosome lesions from his original accident. He had two strand breaks, which is typical of neutron exposures. While these were in his lymphocytes, he had typical cytogenetic lesions of leukemia in his marrow cells.

When asked by the Veterans Administration investigator whether I could say that this man's leukemia was not caused by his exposure, I was able to say I could not say that. So, the Veterans Administration has been taking good care of that man ever since, and, I believe, I heard the other day he is in his fourth remission and there wasn't any problem. I learned on February 28, 1978, that this man died on January 29, 1978.

Mr. ROGERS. Have you had any other, in your studies there, have you had any people with low-level radiation and has there been any showing of cancer or not?

Dr. LUSHBAUGH. The kind of persons that we usually see in this program are persons who are in their careers, like nuclear medical personnel, radiographers; people like that. These people often get burns on their hands; they may get some contamination, or something of this sort. A lot of these persons have not been in the program long enough for us to know whether they have any long-term deleterious effects or not.

Mr. CARTER. Has any leukemia developed in any of that group at all?

Dr. LUSHBAUGH. In the radiation accidents I know of, there have been two cases of leukemia. One was a case of leukemia that developed in what we call the Los Alamos No. 2 accident. He died at Brookhaven National Laboratory some years ago. The other one was this other man I just told you of who showed up several years ago in Columbus, Ohio.

Mr. ROGERS. Now what is the amount of the funding? You say two-thirds from——

Dr. LUSHBAUGH. My total funding is approximately a $3 million program.

Mr. CARTER. So about two-thirds of that is from——

Dr. LUSHBAUGH. ERDA, DOE.

Mr. ROGERS. And the rest from Cancer. You sustain how may people on the $3 million?

Dr. LUSHBAUGH. I say we have 80 persons. That includes custodians, typists, et cetera.

Mr. ROGERS. What would you say is the total budget of the full activity?

Dr. LUSHBAUGH. Of the Oak Ridge Associated Universities?

Mr. ROGERS. Yes.

Dr. LUSHBAUGH. For the first time, it went over $11 million this year. So it is about at $12 million.

Mr. ROGERS. Is that funding pattern basically the same?

Dr. LUSHBAUGH. I would say it is basically the same.

Mr. ROGERS. Now what do you do about peer review of the research programs at ORAU?

Dr. LUSHBAUGH. As I say, our program is annually peer reviewed by a special advisory committee which answers directly to the board of directors who are elected by the representatives of the 45 member universities.

Mr. ROGERS. Which ones do you select to appoint?

Dr. LUSHBAUGH. We don't select them.

Mr. ROGERS. How do they decide that? Do they draw straws?

Dr. LUSHBAUGH. We nominate, but we nominate groups of persons. If we have an immunology program, we have the PI in immunology suggest a list of persons. The board has a special advisory committee of the council that also helps them in their selection.

Mr. ROGERS. Who first contacted you about doing the study at Oak Ridge as a followup to the Mancuso study?

Dr. LUSHBAUGH. The first information that we would call program guidance, I would get from Dr. Sidney Marks of ERDA.

Mr. ROGERS. Dr. Marks was the one who asked you to come in and consider taking over?

Dr. LUSHBAUGH. Right.

Mr. ROGERS. When was that done?

Dr. LUSHBAUGH. That would have been done after I became the chairman, so it was in the spring of 1975, or June of 1975 when I became the permanent chairman.

Mr. ROGERS. Did they ask you to submit any protocol, or the way the study would be done, or the name of the person who would be your chief investigator?

Dr. LUSHBAUGH. As far as I understood it, the protocol, the various sites, and the whole study which had been in place for so many years, roughly 12 years at that time, had been selected by ERDA for these epidemiological studies had already been established. The data was in the process of being collected. The big computers at Oak Ridge had already been selected as the place where these data were going to be stored, collated, massaged, and put out in various forms.

There was a team intact at that time, and the same team is still intact and it runs what is called the computer technology center, which is operated by the Union Carbide Nuclear Co. This group had always received guidance directly from the University of Pittsburgh project grant. The moneys, however, I believe went from Oak Ridge operations to the Union Carbide Co.

What I am trying to say is that there were a lot of pieces of the whole product that were rather firmly established, so that the program was merely transferred, as happens when you have a different person in charge and you have a different principal investigator. The principal investigator, for a long time on the ERDA health and mortality study, of course, was Barkov Sanders, who was the data analyst.

Mr. ROGERS. On which study was that now? Did you say Sanders was in charge of the program before Dr. Mancuso?

Dr. LUSHBAUGH. No. He was doing activities of the kind I would call principal investigator-type activities. This, of course, is only my own idea from reading progress reports and familiarizing myself with the history of the project.

There is no question about the fact that Dr. Mancuso was the person in charge, and that he has now hired Dr. Alice Stewart to be his data analyzer. I would consider Dr. Alice Stewart his principal investigator at the moment, just as I consider Mrs. Tompkins to be my principal investigator at the moment.

Mr. ROGERS. Then you are the contractor with the DOE to carry on this study?

Dr. LUSHBAUGH. No. It would be Oak Ridge Associated Universities who would be the contractor. I would be directed by my supervisor at Oak Ridge Associated Universities, Dr. Philip Johnson, executive director, to be in charge of this program and see that it was carried out. I would, therefore, hire, as I have been doing, competent people to carry out this task which has been assigned to me.

Mr. ROGERS. You have selected Dr. Tompkins to be chief investigator?

Dr. LUSHBAUGH. Yes; I have.

Mr. ROGERS. You selected her in May of 1976?

Dr. LUSHBAUGH. She came to work permanently with me in May of 1976. In December of 1975, she was a consultant to me, because we had to hire young statisticians and other staff. We have one statistician from the University of Florida and the other one from Johns Hopkins University to help us with the important statistics that are necessary to run this program.

Mr. ROGERS. How many people will be working on the program, then?

Dr. LUSHBAUGH. As I see it, at the present time there are three professional staff. We have one other staffer that we think we will be hiring in the next year or so. This will be a young epidemiologist to provide some continuity in the program, so if something should happen to me or Mrs. Tompkins, there would be someone to carry on the project.

Mr. ROGERS. Had any work been done at all at Oak Ridge on the Mancuso study prior to your taking over?

Dr. LUSHBAUGH. There was a group of people from the University of Pittsburgh working at Oak Ridge doing death certificate retrieval and sorting which operated in ORAU buildings but not under our direction.

Mr. ROGERS. Was that part of the Mancuso operation?

Dr. LUSHBAUGH. Yes, although we had nothing to do with it.

Mr. ROGERS. You had not done the study, then?

Dr. LUSHBAUGH. That had been going on for a long time.

Mr. ROGERS. Do you know any of the results of that study?

Dr. LUSHBAUGH. The only result I know is that the Oak Ridge data base is far from being complete and ready to be analyzed. I believe as far as I understand it, it is still in the gathering phase and the death certificate retrievals are up to about 78 to 80 percent of persons that we know have died since 1950. That is one of the difficult tasks, of course.

Mr. ROGERS. You were aware in the summer of 1975, that you would be expected to take over in July of 1977?

Dr. LUSHBAUGH. Yes, sir, I knew that August 1, 1977, was the date I was supposed to take over.

Mr. ROGERS. August 1 would be the day you would take over?

Dr. LUSHBAUGH. That is right.

Mr. ROGERS. Did you submit a protocol or anything to DOE before the date of August 1?

Dr. LUSHBAUGH. Yes. You see, the whole funding process in this situation going through OMB, the Presidential budget and the like, takes about 2 years. So, when you have program guidance like this which says August 1, 1977, it means that your program proposal which you prepare in, say, the spring of 1975 when you would hand it in, would be talking about things that you would be doing in 1977. So, your next proposal which is submitted in the following spring—in 1976—now updates the 1975 one and you begin to pass this budget information and proposals that are based on the programs that you suggest in your 1976 proposals. Schedule 189 level proposals are presently being used by DOE to prepare the Presidential budget, which is now in process for 1980. So, the answer is yes. So we were submitting proposals at this time at what we call the 189 level. These report the progress of the year you are putting it in, the proposal for what you are going to do in the immediate year to follow and the proposal for the year following that which is where the advance funding is taken care of.

Mr. ROGERS. Are these more budget figures rather than actual scientific protocols?

Dr. LUSHBAUGH. No. They contain scientific proposals. Your budget is based on what you say you are going to do, how many man-years are required, and that sort of thing.

Mr. ROGERS. Could you furnish those papers that you submitted to the committee?

Dr. LUSHBAUGH. I am sure we could.

Mr. ROGERS. That would be very helpful, thank you.

[The material referred to may be found in the subcommittee file.]

Mr. ROGERS. Dr. Tompkins, you were with EPA and did epidemiological work.

Mrs. TOMPKINS. Yes. I was chief of their special pollutant branch in the Research Triangle Park, EPA laboratories.

Mr. ROGERS. And before that, whom were you with?

Mrs. TOMPKINS. With the Bureau of Radiological Health.

Mr. ROGERS. And before that?

Mrs. TOMPKINS. I was out for a year being a housewife. Before that, I was with Stanford University Medical School conducting a study on acute childhood leukemia. I was there for 4 years. Before that, I was a student and a mother.

Mr. ROGERS. What were the conclusions of your childhood leukemia study?

Mrs. TOMPKINS. It was a study designed very similar to that of the Oxford study in England. It found an increased risk of children who had leukemia of having been X-rayed as compared to their siblings. It did not find the same relationship with the other control group which were playmates.

Mr. ROGERS. So, your final conclusion was that X-rays——

Mrs. Tompkins. The final conclusion was that children who had leukemia had a higher probability of having received X-ray in utero than their siblings who did not have leukemia.

Mr. Rogers. Which was similar to the Stewart study?

Mrs. Tompkins. Yes, sir.

Mr. Rogers. Did you find the same risk as in the Stewart report?

Mrs. Tompkins. I don't think we ever calculated a risk before I left. The risk calculations came up much later. This was in 1959, 1960.

Mr. Rogers. So you did not draw a conclusion as to what the risk was?

Mrs. Tompkins. Understand that the purpose of the study at that point was to try to understand what might be associated with childhood leukemia, going in the other direction. Radiation was one of the risks that was looked at. There were others which were found to be significant, also. But I assumed the interest of the committee was in the radiation.

Mr. Rogers. From what you have done, do you expect a negative result from the analysis of Oak Ridge workers?

Mrs. Tompkins. I have no idea.

Mr. Rogers. You have not really started yet?

Mrs. Tompkins. No, sir. There has been no analyses of the Oak Ridge data at all.

Mr. Rogers. Did you work for Dr. Saenger?

Mrs. Tompkins. No. In the cooperative thyrotoxicosis followup study, there were 27 institutions that provided data. Dr. Saenger was the study director for one of these, the University of Cincinnati. Dr. Saenger was selected by the 27 study directors to help write the paper on leukemia. The study directors felt it was their data and they were not going to depend on any Government agency to interpret their data by themselves. So they selected members of their group, the study directors, to work with us in preparing the manuscript.

Mr. Rogers. Were you familiar with his work in the radiation given to cancer patients?

Mrs. Tompkins. I have become aware of it since, certainly.

Mr. Rogers. Giving whole body dose, I take it, is what he did?

Mrs. Tompkins. Yes.

Mr. Rogers. I am sure you would not approve of that study?

Mrs. Tompkins. I really have no basis to think about it. I have read about it in the newspapers, that is all. I have never read the protocol or anything else technical.

I certainly would never do it, if that is what you are asking, yes, sir.

Mr. Rogers. I am sure of that.

Would you agree with Dr. Radford that health effects are now shown to be more serious than the 1972 BEIR report suggested?

Mrs. Tompkins. I think there is little doubt that each time a large review is done you look at the data which is available up to that point in time. The Japanese and the ankylosing spondylitic patients are the two groups which have continued to be followed over a long period of time. The first time it was thought the increased risk would be limited to 20 years, then 30 years, and now

I think it will be 40 years. So the continuing risk overtime obviously increases the magnitude of the risk.

Mr. ROGERS. Is it only a changing perception of risk, or new scientific thinking as to the effect of low-level radiation, in which there seems to be some change of scientific viewpoint?

Mrs. TOMPKINS. There is a mixture, I think, between scientific thinking and standard setting thinking. You can only evaluate the data that you are looking at, and what you are looking at is dependent on what data are available. Certainly when the reviewers come along, they try to look at all the available data. If there is more and more data, certainly I hope that they are considering it all, not just part of it.

Mr. ROGERS. I asked if you agree with Dr. Radford, with your knowledge, and I presume you read the literature?

Mrs. TOMPKINS. The one he is talking about is not published yet.

Mr. ROGERS. I think he said that increased his concern to such a degree that he would go far below what Dr. Hutchinson would recommend.

What I am asking is does your review of current literature lead you to believe that the health effects of radiation are now shown to be more serious than the 1972 BEIR report suggested? Or do you think that is still the document that we should go by?

Mrs. TOMPKINS. No, sir. Somehow——

Mr. ROGERS. I do not mean to try to confuse you. I am just trying to get your thoughts; if you think there is a problem or there isn't.

Mrs. TOMPKINS. Certainly, sir, I have always thought there was a problem, or I wouldn't be in this research field.

Mr. ROGERS. What I am asking concerns the 1972 BEIR report, as far as its being the document to prevail now. In other words, would you stand by that now? Would you have a change of standards or not?

You did not agree with it, then?

Mrs. TOMPKINS. That is right.

Mr. ROGERS. In what degree did you think it was too conservative or too liberal? Does it relax the rules or tighten them up too much for you?

Mrs. TOMPKINS. It did not make any rules.

Mr. ROGERS. It suggested the basis for some standards, didn't it?

Mrs. TOMPKINS. No; I don't think that was the purpose of the BEIR report.

Mr. ROGERS. What was its purpose?

Mrs. TOMPKINS. It was to make a review of the current literature to best estimate the risk associated with exposure to ionizing radiation.

Mr. ROGERS. What did they do on fallout? If they made an estimate, it would stand as a scientific basis for intelligent judgment on the setting of standards.

Mrs. TOMPKINS. Certainly it should be used for that purpose, but along with other documents, I would hope.

Mr. ROGERS. That is why I am asking you if you have knowledge of other documents, and I presume you keep up with the literature since you are doing radiation studies.

Do you think the 1972 BEIR report should prevail today or have there been studies which cause you to think maybe there is more of a problem than even suggested there?

Mrs. TOMPKINS. Certainly some of the things which I have heard in this hearing room over the past 2 weeks suggest there are some very interesting findings. I should say, scientifically interesting findings. I hope you understand what I mean by that.

Mr. ROGERS. Well, I am not sure.

Mrs. TOMPKINS. They should be pursued. They should be pursued scientifically, certainly.

Mr. ROGERS. Would you let us have your curriculum vitae for the record?

Dr. LUSHBAUGH. I thought they had been handed to you.

Mr. ROGERS. We have not seen them.

Dr. LUSHBAUGH. We sent them to Dr. Liverman. Maybe they got waylaid at that point.

Mrs. TOMPKINS. I assumed it was part of your request, for the CV's, of all the studies that you requested 2 weeks ago. We will send you CV's.

Mr. ROGERS. We will check it.

Has work actually begun now on the new study?

Mrs. TOMPKINS. On the Oak Ridge study?

Mr. ROGERS. The followup of the Mancuso report at Oak Ridge?

Mrs. TOMPKINS. Yes.

Mr. ROGERS. What have you done?

Mrs. TOMPKINS. We have established the operating procedures for the central office for death certificate retrieval. We have not established procedures with social security because the contract has not been signed and they are unwilling to talk to us until it has been.

Mr. ROGERS. You have not yet signed the contract with DOE?

Mrs. TOMPKINS. The contract with social security, an interagency agreement between DOE and the Social Security Administration.

We have been working constantly with the computer technology center which is providing the computer support, developing the programs which are needed for analysis, expectancy, and person-years calculations. All of these computer programs are now in operation. We are working toward the primary goal, which is to edit all the data which are in the bank. The data were gathered, abstracted and put onto tape and had never been checked for accuracy, cross-consistency. That is where we are.

Mr. ROGERS. Have you submitted your protocol to DOE?

Dr. LUSHBAUGH. Yes; the 189 previously submitted and also one which is right now in the first phase and has a deadline for submission of April 3 of this year.

Mr. ROGERS. That will be a complete protocol?

Dr. LUSHBAUGH. As complete as 189 protocols ever are.

Mr. ROGERS. Which is how complete?

Dr. LUSHBAUGH. They are not as complete as an NIH unsolicited proposal. They don't come in with all the documentation and all the science and history like an NIH proposal does.

Mr. ROGERS. Should they?

Dr. LUSHBAUGH. If they should, I would sure have a hell of a job. It would be quite a task because quite a few are submitted. I think the national lab in Oak Ridge submits over 500, I believe, on an annual basis.

Mr. ROGERS. Do you have that many projects going?

Dr. LUSHBAUGH. I don't submit that many. I submit only 10. Yes; there are that many 189 projects at the National Laboratory.

Mr. ROGERS. 1,100 with a budget of $11 million?

Dr. LUSHBAUGH. No; the OR National Laboratory is another laboratory at Oak Ridge. That is the big laboratory. There is the Oak Ridge National Laboratory, which is quite separate from Oak Ridge Associated Universities.

Mr. ROGERS. I was speaking of your operation.

Dr. LUSHBAUGH. In my division, I submit ten 189 proposals.

Mr. ROGERS. You are a division of Oak Ridge National Laboratory?

Dr. LUSHBAUGH. No; I am a division of Oak Ridge Associated Universities, which is a $10 million project. The biology division at Oak Ridge National Laboratory is a $17 million operation. The whole Oak Ridge National Laboratory, I believe, is something on the order of $170 million. All the proposals come in as 189's, you see.

Mr. ROGERS. Even though it is a health effects study?

Dr. LUSHBAUGH. Even though it is a health effects study or what.

Mr. ROGERS. Is there much reason to distinguish between doing health studies at NIH and health studies done here at DOE?

Dr. LUSHBAUGH. The answer to that is rather complicated in that the studies that are being submitted to NIH are unsolicited. They come in from anybody who wishes to submit one.

Mr. ROGERS. They are peer reviewed; are they not?

Dr. LUSHBAUGH. Well, there is a peer review study section where they are reviewed on the basis of scientific merit, priorities are assigned and the ones with the highest priority get the money. There is a competitive type of competition for funding.

Mr. ROGERS. Yours was already signed before they saw the protocol?

Dr. LUSHBAUGH. Well, in a sense, yes, except they knew what the protocol was going to be, however.

Mr. ROGERS. He did not even know who the chief investigator was going to be. So how could he know what the protocol was going to be?

Dr. LUSHBAUGH. He can know the protocol when he assigns it.

Mr. ROGERS. I won't argue that with you. All I am saying is that there is a question concerning the procedure used by DOE for health effects studies.

Mrs. TOMPKINS. Having worked in the Bureau of Radiological Health, which is HEW, but not a National Institute, and EPA, this is exactly the same procedure we used there. It is not unique to DOE. In fairness, I feel I have to say this.

I think the Institutes are the unique ones in the Government in health research effects.

Mr. ROGERS. Yes, that is why I would think the principal health effects studies should be done by the health agencies of the Government and not by energy agencies.

Mrs. TOMPKINS. At HEW, it is done the same way.

Mr. ROGERS. That has already been transferred over to EPA?

Mrs. TOMPKINS. No, sir.

Mr. ROGERS. There is not very much left at the Bureau of Radiological Health. It is a very small program.

Neither of those programs has been funded very well.

Mrs. TOMPKINS. Because the Office of Radiation said to the research division in EPA that they did not need any research, so we didn't get funded; you are right.

Mr. ROGERS. I am saying that even in the Bureau of Radiological Health in HEW, the funding has been practically nil.

Mrs. TOMPKINS. I agree.

Mr. ROGERS. What I am concerned with is if we are going to do health effects research, maybe it ought to be done in the health branch as such under the NIH where we do research, have peer review, and have competition.

Dr. Carter.

Mr. CARTER. What is an RFP?

Dr. LUSHBAUGH. That is a "Request For Proposal."

Mr. CARTER. How is the contract process for the Department of Energy opened for competitive bidding?

Dr. LUSHBAUGH. We—ORAU—are not able to respond to RFP's. The minute a RFP goes out, it freezes our hands. If I have something that I think I could do or I could do the study that the RFP comes out for, I am unable to compete because under the Federal rules, it is considered that governmental contractors would have a headstart working in a government-endowed building and the like, and they would be able to come in at a lower price and would be the kind of competition that the other competitors could not compete with. So I am, therefore, excluded from responding to RFP's.

Mr. CARTER. Mrs. Tompkins, what procedures were followed to publish findings from your study?

Mrs. TOMPKINS. Specifically which studies?

Mr. CARTER. Studies on the use of iodine-131.

Mrs. TOMPKINS. The leukemia paper was first drafted, as I said, by Dr. Saenger, Dr. Thoma, and myself. The draft paper was then sent out to all of the 27 study directors for review. It was also reviewed within the Bureau of Radiological Health.

I can assure you a negative finding didn't please the Bureau too much, either. They reviewed it very carefully. When all of these people approved—it took about three drafts—it then went to our advisory committee for a special review. This is a group of about 12 scientists with no relationship to the Bureau. When they made their comments we then rewrote it. It was submitted to a refereed journal and was published in JAMA.

Mr. CARTER. Would you take an iodine-131 injection?

Mrs. TOMPKINS. If I have hyperthyroidism and had my choice between surgery and drugs or iodine, yes, sir, I would.

Mr. CARTER. How soon do you anticipate publishing your results on the continuation of the Mancuso project?

Mrs. TOMPKINS. It completely depends on how long it takes us to get the data cleaned up. At this moment, we hope to start analysis a year from now.

Mr. CARTER. To get it cleaned up? Is it a mess now?

Mrs. TOMPKINS. Pardon?

Mr. CARTER. Is it in some sort of a mess?

Mrs. Tompkins. Yes, sir, it is.

Mr. Carter. How do you account for that?

Mrs. Tompkins. I think in the situation in which data are gathered without very careful supervision and without written protocols by people who do not understand what kind of decisions they are making when they make decisions on changing, how they are abstracting data for example, this result always happens. The data were put directly into the computer without making sufficient effort to assure accuracy or consistency. We are now in the position of having to try to check these data.

Mr. Carter. You are referring to the Mancuso study now?

Mrs. Tompkins. I am talking about the data in the computers for the Oak Ridge population; yes, sir.

Mr. Carter. That is left in a mess?

Mrs. Tompkins. Nothing was ever done with it. It was simply entered into the computer and that was that.

Mr. Carter. It was entered into the computer?

Mrs. Tompkins. That is right.

Mr. Carter. But findings were published?

Mrs. Tompkins. No, sir.

Mr. Carter. A few years previous to that, were they not?

Mrs. Tompkins. No, sir. The Oak Ridge data has never been analyzed.

Mr. Carter. I am referring to Hanford.

Mrs. Tompkins. The Hanford data is a completely different set of data.

Mr. Carter. Oak Ridge just had not been done?

Mrs. Tompkins. That is right.

Mr. Carter. Does anyone control what you do with your results?

Mrs. Tompkins. What do you mean by control?

Mr. Carter. Exactly what I said.

Mrs. Tompkins. You mean censor, stop me from publishing?

Mr. Carter. Yes.

Mrs. Tompkins. I would quit tomorrow if someone did.

Mr. Carter. Good.

How long does radioactive iodine last in the human body?

Mrs. Tompkins. About 40 days.

Mr. Carter. That is the entire life of it?

Mrs. Tompkins. Pardon?

Mr. Carter. Is that its entire life? How many rads of X-ray does one get, an average person, average weight, for an abnormally large thyroid?

Mrs. Tompkins. You mean treatment dose to the thyroid with radioactive iodine?

Mr. Carter. Yes, when he receives treatment, how many rads will he receive?

Mrs. Tompkins. You want the whole body dose or thyroid dose?

Mr. Carter. Thyroid dose.

Mrs. Tompkins. Between 6,000 and 10,000 rad.

Dr. Lushbaugh. That is the therapeutic thyroid dose.

Mr. Carter. Between 6,000 and 10,000 rad.

Mrs. Tompkins. Somewhere between 6,000 and 10,000 rad.

Mr. Carter. What is the total body dose?

Mrs. Tompkins. About 12 rad.

Mr. **Carter**. I believe I will take the surgical treatment, Mr. Chairman.

Mrs. **Tompkins**. I was counting the surgical deaths and comparing them to the leukemias.

Mr. **Carter**. I am sure there are some.

Mrs. **Tompkins**. The risk is 1 per 1,000 surgical death in the best situation, and with the increased use of iodine-131, the surgical expertise in thyroidectomy is not there like it used to be.

Mr. **Carter**. That may be right. We are finding out more and more as we go along. At one time we let atom bombs go off in the air. Then, for a short while we put them underground. We began to monitor the fallout from China when it came over the United States for strontium in the milk and things like that. I feel that the next move that could be made would be to ban the use of atomic weapons entirely.

Mrs. **Tompkins**. You have a lot of sympathy there, sir.

Mr. **Carter**. That is the history of the way things have gone as I see it. Really, I am not as optimistic as you are about iodine-131.

Mr. **Rogers**. Mr. Walgren.

Mr. **Walgren**. I want to explore a couple of things. I am interested in the public's understanding of this kind of study. Yesterday we had testimony by Dr. Radford, I believe, in which he said that it took the army a long time to catch up to the scientific data that the higher doses of radioactive exposure related to nuclear bombs was severely detrimental; that the scientific community preceded the military by a matter of several years, and I am afraid at least thousands of exposures. I am concerned that in the public view these health studies may be suffering from the same kind of time lag.

To that effect, I wanted to ask Dr. Lushbaugh, when the Veterans Administration asked you whether or not the illness that that young man was suffering from——

Dr. **Lushbaugh**. He is 55 now.

Mr. **Walgren**. But the person who suffered the classic breaks in chromosome and tissue——

Dr. **Lushbaugh**. He is the one.

Mr. **Walgren**. You said you told them that you could not say that he did not incur it from radiation. Dr. Lushbaugh, do you believe that he did incur it from radiation?

Dr. **Lushbaugh**. I believe that because he had persisting neutron damage in his lymphocytes that this kind of damage, in my mind, is the crude measure of even smaller kinds of damage which could lead to his leukemia.

So, if I had to say, "I would bet yes, it was, or no, it wasn't," I would bet yes, it was.

Mr. **Walgren**. Let us go beyond the bet. Let us say you were sitting on a jury trying that issue of fact. The judge said to you, "Now the question you must resolve is whether or not this sickness was caused by radiation, and you must believe that beyond a reasonable doubt"—I wish I could recite the exact legal instruction, but "A reasonable doubt is a doubt which serves to convince you. It does not mean that there can be no doubt in your mind, but it is that state of the evidence which rises to the point that you believe to a moral certainty that this was cause and effect."

Do you believe that beyond a reasonable doubt?

Dr. LUSHBAUGH. Let me say this. I believe the doubt should always be on the side of the patient. I believe that the person making the suit does not have to prove his point. If I can't disprove it, why, he wins.

Mr. WALGREN. Given the need for public understanding and for the protection of the public, and keeping in mind who should make these judgments about health damage from radiation, do you believe, given the evidence today, that that boy's sickness was caused, beyond a reasonable doubt, by exposure to radiation? Yes or no.

Dr. LUSHBAUGH. You have me so twisted there. As a physician, I don't know how to answer your question.

Mr. WALGREN. My problem is that the public has given to the Department of Energy an awful lot of money and the responsibility of protecting the public's health in this area.

The question to that person to whom we gave that money and that responsibility is: Does that person believe, in the instance of that boy you testified to earlier, does that person believe that radiation caused his cancer, beyond a reasonable doubt?

Dr. LUSHBAUGH. I knew what I was doing when I said to that VA man that I thought I could not say that his leukemia was not caused by the radiation; I was really saying to him that it was. I would have to say it that way. I believe that that man had everything on his side and his leukemia should be considered a radiation-induced leukemia.

Mr. WALGREN. I would be more comfortable, from the public point of view, if the people to whom we gave that kind of responsibility came out on that more directly.

Do we have a vote?

Mr. ROGERS. We do.

The committee will stand in recess for 10 minutes.

[Brief recess.]

Mr. WALGREN [presiding]. If we could come to order and resume the hearing, please.

When we left off, we had just covered whether or not Dr. Lushbaugh would agree that radiation caused beyond a reasonable doubt the illness of the person described earlier. I think it would be fair to say that most people would describe your admission of that as reluctant. I only say that——

Dr. LUSHBAUGH. May I explain why?

Mr. WALGREN. Yes.

Dr. LUSHBAUGH. Because where I think everybody who has leukemia that has been caused by radiation should be taken care of and paid. I have no problem with that—there are many people who have leukemia that have never been irradiated. One of the difficulties I have is trying to be evenhanded about the problem and coming to some objective decision. If the person says he has been irradiated, I have to evaluate that as evenhandedly as I can with the information available to me. Just because a person has acute myelogenous leukemia does not mean to me that he was irradiated sometime when he did not know he was irradiated because he said he was.

I believe one should make these decisions on the basis of facts. When you don't have the facts, then you must decide on the side of the patient.

Mr. **Walgren**. So in this case, you decided on the side of the patient.

Dr. **Lushbaugh**. Because I had some facts in his favor.

Mr. **Walgren**. And those facts were very clear, were they not?

Dr. **Lushbaugh**. Right.

Mr. **Walgren**. So in this case, your feeling that you should err on the side of the patient did not enter into the situation at all, did it?

Dr. **Lushbaugh**. It did not have to.

Mr. **Walgren**. It was very clear to you?

Dr. **Lushbaugh**. I felt good about it.

Mr. **Walgren**. It was clear to you that in this case, the damage was caused by the radiation.

Dr. **Lushbaugh**. I would accept that as a bona fide case, right.

Mr. **Walgren**. All I want to do is just say——

Dr. **Lushbaugh**. I will give you another example. I am faced with a case——

Mr. **Walgren**. My point is simply this; that you still seem unwilling to say that it was caused by radiation.

Dr. **Lushbaugh**. Only because the science has not yet developed that says that when you have these chromosome breaks in your lymphocytes you can extrapolate from their presence to a cancer. One of the hypotheses is that they are some way involved, but it has not yet been shown. As an ordinary physician and nonscientist, I do accept it at that level.

Also, since I am a part-time scientist, I have to have a scientific side of me, too. That is where I had most of my difficulty in this, not as a practicing physician but as a practicing scientist. We need more science.

Mr. **Walgren**. Perhaps you could continue then and say what you wanted to say before when I stopped you. I apologize for having stopped you.

Dr. **Lushbaugh**. I will cite another typical case that gives me a problem. A man who was on Eniwetok driving a bulldozer for 5 months and got five-tenths of a rad; 20 years later he shows up with acute myelogenous leukemia.

A physician in the port where he worked in the 20 years since, says it is "a typical radiation-induced leukemia." But then, as you read the man's chart, you find out he worked in the repair pits under heavy equipment for the port authority where he was exposed to PNA's, diesel fuel effluents and all sorts of products which are known to be leukemogenic.

I am supposed to say this man did or did not have radiation-induced leukemia. I said he did not.

Mr. **Walgren**. I just want to note for the record that the difficulty in securing a direct admission from you was related to the case that you testified had classic radiation breaks in lymphocytes, and yet you were still unwilling to say that it was cause and effect beyond a reasonable doubt.

My problem is this. I believe that the public invested in you a tremendous amount of their faith in raising questions about radiation hazards. I think that the representative of the public should take into account the reluctance of somebody in whom that faith is placed to make an admission that I think we all will agree is true.

Now I wanted to pursue a little bit your feelings in changing the investigators on the Mancuso study. You indicated that it was a mere change in the person in charge. Now do you feel that the person in charge and their attitudes toward nuclear energy may have some effect on the conclusions drawn on the study?

Dr. LUSHBAUGH. They could have an effect, but let me say that they should not have an effect because the science on the study is actually done by the analyzer, the person who is doing the analysis, the epidemiologist, the scientist. If the person in charge is going to be a censor and wipe the conclusions out, then you have a bad person in charge. I don't believe I am that kind of person.

Mr. WALGREN. In this instance you considered yourself to be the person in charge?

Dr. LUSHBAUGH. I am, at the moment. But I am not the principal investigator. I am not the epidemiological scientist. Mrs. Tompkins is.

Mr. WALGREN. Did you think the attitudes of the principal investigator could, in any event, affect the conclusions drawn?

Dr. LUSHBAUGH. Not if she is a scientist. I don't think the attitudes of a scientist should interfere with the scientific facts.

Mr. WALGREN. Do you believe that similar statistics can lead to different conclusions?

Dr. LUSHBAUGH. They can lead to different interpretations, of course. I think that you certainly have a point in that people interpret from their point of view and from their motivation. But I can assure you, after having been in this field for 30 years myself, I am not going to tolerate somebody who believes that irradiation is an innocuous type of activity. I have a record that stands for itself as having worked for patient benefit, for radiation safety and radiation pathology, trying to understand what is going on. I don't think I have ever belittled any type of radiation study that was motivated for the patient's good.

Mr. WALGREN. In appointing the principal investigator in this case, did you take into account their viewpoints on the effects of radiation?

Dr. LUSHBAUGH. Certainly, I did.

Mr. WALGREN. Did you evaluate Dr. Tompkins in that respect?

Dr. LUSHBAUGH. Yes; I did. I evaluated her by reading her papers, by talking to her and by talking to her peers.

Mr. WALGREN. Which peers recommended Mrs. Tompkins?

Dr. LUSHBAUGH. Dr. Victor Bond was one. Dr. John Storer was another. Dr. Seymour Jablind was another. Dr. Eugene Saenger was another, Dr. Norman Telles was another. I don't have my whole laundry list with me.

Mr. WALGREN. Were you familiar with Dr. Saenger's work?

Dr. LUSHBAUGH. Dr. Saenger's work? Which set of Dr. Saenger's work?

Mr. WALGREN. Whole body irradiation.

Dr. LUSHBAUGH. Whole body irradiation, yes, I was.

Mr. WALGREN. Did you know in some detail about the experiments in which Dr. Saenger was involved in the mid-1960's?

Dr. LUSHBAUGH. Yes; I did. As a matter of fact, one of the reasons I did was because we were studying the effects of total body irradiation in human beings who had various kinds of blood dyscrasias. We were using whole body exposure to treat those diseases. We were obtaining very beneficial results.

I was looking at what he was doing with solid tumors with a critical and comparative eye.

Mr. WALGREN. Have you collaborated with Dr. Saenger in the studies in your past?

Dr. LUSHBAUGH. Not directly with him, no.

Mr. WALGREN. Dr. Tompkins has collaborated with Dr. Saenger?

Dr. LUSHBAUGH. Correct.

Mr. WALGREN. You were aware of her ongoing work with him?

Dr. LUSHBAUGH. Yes, at the Bureau of Radiological Health in 1962, yes.

Mr. WALGREN. Do you believe that Dr. Saenger's recommendation is a recommendation that the public should take in setting radiation standards and have confidence in?

Let me take that back.

Dr. LUSHBAUGH. You seem to——

Mr. WALGREN. Having confidence in Dr. Saenger's recommendation as to radiation exposure and danger?

Dr. LUSHBAUGH. I know that Dr. Saenger is an extremely dedicated person in the treatment of local radiation injuries. He is an expert in radiation accident management. I infer from what you are saying that you don't believe that his statements about radiation should be given any credence. You are entitled to your opinion, but I don't believe that. He has not been hired at that level by me.

Mr. WALGREN. Putting yourself in the shoes of the public and knowing what has been written about Dr. Saenger's work, do you believe that Dr. Saenger's recommendation should now be taken to set health radiation standards for the public? Do you believe the public would say that is a good judgment?

Dr. LUSHBAUGH. Well, I believe that Dr. Saenger is certainly justified in having opinions about radiation standards, after some 30 years of being in the business himself. He certainly is entitled to his opinions about whether they are adequate, and I think that he is a scientist and I think he is well written. I think he has been outspoken. I think he has been a constructive critic in the whole field.

I think much that has been written about him and the studies that were going on at the University of Cincinnati are not all true and some of it is distorted. I think it is completely unfair to say it is all true and that, therefore, he should be blackballed.

Mr. WALGREN. Suppose Dr. Saenger was applying to be your principal investigator; would you believe that he should be in that position, given the necessity of the public to put faith in the outcome of your study?

Dr. LUSHBAUGH. Well, it would have to depend on the study. If the study we are talking about involves statistical relationships, I certainly would prefer a mathematician or statistician. I believe that Dr. Saenger is a medical scientist. I don't believe that he is not.

Mr. **Walgren**. Assuming Dr. Saenger had the qualifications that you were looking for in a principal investigator and given the critique of his work that has become public knowledge, would you choose him for that position?

Dr. **Lushbaugh**. Now I have to change hats to be a manager. I am not being facetious at the moment, but I would say it would be politically dumb to accept him as a manager. I think everything that you say I can't erase. Since I have to compete in the marketplace, as a manager of a study or a person in charge, I don't think that I would be wise to take Dr. Saenger on as my principal investigator.

Mr. **Walgren**. Yet you were willing to give some weight to his recommendation as to whom you should take on.

Dr. **Lushbaugh**. I don't understand why there is anything wrong with that.

Mr. **Carter**. Mr. Chairman, on that very thing, what is wrong with that is Saenger's treatment of 87 patients for radiation, I believe. What is bad is that 87 patients died within 60 days. They may have been terminal and they may not.

There is a great deal of question about it, and a book written about it, I believe called Silent Slaughter.

Thank you for yielding.

Mr. **Walgren**. You understand, I take it, why the public would greet with some skepticism the results of the study? You have testified that the principal investigator was not only an associate of Dr. Saenger, although not in that particular study, but was also recommended to you by Dr. Saenger.

Dr. **Lushbaugh**. Let me correct that. Dr. Saenger did not recommend Mrs. Tompkins to me. When I learned that Mrs. Tompkins had worked with Dr. Saenger, I asked Dr. Saenger what were her credentials and how did she work and how would one work with her, and this sort of thing. I did not seek a recommendation from him. I was just following up what is my normal protocol of checking out somebody. I know Dr. Saenger very well.

Mr. **Walgren**. One of the problems in this whole area is that it is so tough to get an independent view, and the public must have one or they cannot put any faith in what you produce. It is so directly comparable to the policies about the Vietnam war where certain people have made decisions and a number of people have gotten killed in the pursuit of those decisions. It was very clear that those people could never rethink those decisions without reaching the conclusion that they were responsible for those deaths and were wrong. Those decisions were never rethought until we changed every person that was involved in them.

In this case, we have people in the nuclear industry who have been very close to the high radiation levels; people have died in the exposure to those radiation levels.

Dr. Saenger's experiments read like something out of Frankenstein. There is no getting around that. The relationship between Dr. Saenger and the Department of Defense seems quite clear, at least to great parts of the public who have to rely on the results of your study.

It would seem to me that anybody with that kind of responsibility would reach out for somebody who is—Lord knows, we asked

President Carter to come up with Sam Dash for the prosecutor in Philadelphia and will fault him for anything short of that—and the public reaches out to you for the same kind of impeccable independence and not somebody recommended by one who is in tremendous disrepute by much of the public or who has a background and close relationship to the high levels of radiation, the justification of radiation exposure in the past.

Don't you believe it is incumbent on you to come up with somebody as the principal investigator in your work in the discharge of your duty that is not subject to that kind of attack?

Dr. LUSHBAUGH. I can answer that yes, but can I extend my answer?

Mr. WALGREN. Yes.

Dr. LUSHBAUGH. I think that you seem to have forgotten that Dr. Saenger was the only person I knew among the 27 physicians involved in the thyroid toxicosis study. I knew him very well, so I felt I could ask him for his opinion. Mr. Tompkins and he were not the chief collaborators, as was explained earlier. These were not two cronies in cahoots in a scientific study. Mrs. Tompkins was the epidemiologist working with a group of 27 physicians of which Dr. Saenger was 1. I don't understand; it would be very difficult, I would think, in the field of radiation accident management and this sort of thing to find people who have not worked with Dr. Saenger because he has been one of the foremost persons working with radiation accidents. I don't think it makes me some kind of peculiar person because I know Dr. Saenger and get along with him very well.

I can disagree with Dr. Saenger, and there are areas I can agree with him. I am a highly motivated person for helping people who have been irradiated, but from my own experience with patients with leukemia, total body irradiation does slow down myelocytic processes. My patients with leukemia who were getting whole body irradiation did very well. We had average survival times in patients with chronic myelocytic leukemia of more than 4 years, which is as good as anybody ever got with chemotherapy at that time.

I don't believe that it necessarily damns anybody who has used total body irradiation in the treatment of malignancy. There was a time when that was the only thing you could use.

Mr. WALGREN. Do you know Dr. Saenger well?

Dr. LUSHBAUGH. Yes; I do.

Mr. WALGREN. You have substantial respect for him as a scientist, as you testified?

Dr. LUSHBAUGH. Yes; I do.

Mr. WALGREN. I would like to enter into the record at this point certain pages of that book that Dr. Carter just cited, "Silent Slaughter."

[Testimony resumes on p. 819.]

[The following excerpt was supplied for the record:]

Saenger is considered a pioneer in the field of nuclear medicine. Since 1956 he has been chief of the Radioisotope Laboratory at the University of Cincinnati Medical Center, one of the busiest nuclear medicine establishments in the country. As regards his role in the PHS study, then, Saenger in effect was conducting a study of whether he and his profession had been increasing the incidence of cancer among their patients all these years. Saenger has been quoted as saying that soon, "any part of the field of nuclear medicine should be as good or better an investment than IBM or Coca-Cola from the time they were founded." A member of the National Committee on Radiation Protection, he has spoken out strongly against any lowering of the present permissible radiation exposure limits.

In the fall of 1971, Saenger's radiological practice achieved international notice. It seemed that for the preceding decade, he and his colleagues at the University of Cincinnati had been conducting what they described as an experimental cancer research project, designed to investigate whether radiation could increase the lifespans of patients with incurable cancer. In the project reports issued by Saenger and his team over the years, case histories were given for 87 patients who had received the radiation treatment. According to the team's reports, prior to treatment all of these patients had been in "relatively good health" and not in the final stages of their disease or close to death. Yet after receiving Saenger's radiation treatment, 25 of the 87 patients died within sixty days.

What was this treatment being given by Saenger and his colleagues? According to the team's reports, many of the patients had been given whole-body or half-body radiation doses ranging as high as 250 rads, "with even higher doses planned...." Whole-body radiation, or radiation to the upper half of the body, is far more lethal than radiation to a small part of the body. For instance, therapeutic doses of thousands of rads can be used to destroy localized cancer tumors without killing the patient. But according to the most recent estimates, only

Henry Regnery Company, Chicago: 1972 (pp. 113-122)

300–400 rads given to the whole body over a relatively short period of time will kill 50 percent of the people exposed to it within sixty days. Saenger was giving his doses over a short period of time—between a half-hour and an hour.*

Whole-body radiation has frequently been used for treatment of leukemia and other types of cancer that affect large areas of the body, but not the way Saenger was using it. In other medical institutions, the doses were much lower. According to a definitive textbook on the subject—*Leukemia* by Drs. William Dameshek and Frederick Gunz, published in 1964—when using whole-body radiation for leukemia, "Relatively small doses must be given (25 rads or even less) to avoid too-great bone marrow injury and other reactions." Yet Saenger was giving his patients up to 250 rads. In recent years, it has become possible to use much higher doses (delivered gradually over weeks or months) by giving the patient transplants of healthy bone marrow after irradiation.

But it was not until 1966, after forty-eight patients had already been irradiated, that Saenger and his team began attempting to use bone marrow transplants, and even with the transplants, patients continued to die within a month or two after treatment. Furthermore, Saenger's patients did not have leukemia or any of the other types of cancer that are commonly considered responsive to radiation treatment. They had cancers of various body organs, such as the colon, lung, and breast, that had metastasized to varying degrees. None of the medical groups that have investigated the situation were able to cite a single instance where whole-body radiation consisting of hundreds of rads delivered in a half-hour to an hour has been used on patients with this or any other type of cancer, except by Saenger.

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*For example, according to his fourth study report, covering the years 1960-66 and entitled "Metabolic Changes in Humans Following Total-Body Radiation": "Treatment time was one-half to one hour. Dose rates were 3 rads/minute to 6 rads/minute."

Who were the patients who received Saenger's treatment? All but three were charity patients from Cincinnati General Hospital, and none could pay for their medical care. They had an average schooling of six years and an average I.Q. of 86 (normal is 100). Many were elderly, and few had immediate relatives. About 60 percent were black. Saenger and his team said these patients were given a full explanation of the risks before they signed for the treatment.

Aside from "experimental cancer research," were there any other possible reasons for Saenger's choice of treatment? It turned out that his entire project was operated under contract to the U.S. Department of Defense, which had contributed funds totaling $650,000. According to the Pentagon's research abstract for the project, it was interested in finding out about potential "reductions in combat effectiveness" in troops exposed to large doses of whole-body radiation of the type that would occur in a nuclear war. These were precisely the kinds of doses that Saenger and his team had been giving to the patients. In its public statements on the matter, the Pentagon maintained that its role in the project was part of its "continuing support of medical research." However, the Pentagon sent the results it received from Saenger to dozens of weapons-testers and military officials, but not to a single civilian cancer researcher. The Army medical liaison officer for the project was a veterinarian.

In the wake of the disclosure, two reports were issued that attempted to resolve the issues surrounding the controversy. One was put together by a Junior Faculty Association committee from the University of Cincinnati, with extensive help from members of the medical community.* The other report came

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*This report was subsequently published in *Drug Research Reports, Supplement* for February 16, 1972.

from the American College of Radiology, the radiologists' professional organization to which Saenger belonged. The following information was drawn from these two reports.

The faculty committee report opened with this statement: "We have come to the conclusion that many patients in this project paid severely for their participation and often without even knowing that they were part of an experiment. We feel that the evidence clearly calls into question the manner in which these human experiments were designed and carried out. We therefore urge the president of the University to terminate this project and to instruct the Medical Center to cooperate fully with . . . congressional hearings. . . ."

One vital question surrounding the controversy was: When had the project actually begun? If Saenger and his team had been using this treatment on patients well before the Pentagon contract was signed, then this would indicate that the treatment could not have been designed primarily for the benefit of the Pentagon. Saenger stated publicly that the project had been going on since 1955, five years before the Pentagon support began. However, the faculty committee report noted that there was in fact no evidence that any patients had been irradiated prior to 1960, the year the Pentagon contract took effect. The committee concluded that "the two projects, research on cancer and research on radiation injury (if indeed there were 'two'), seem to have been coterminous." That is, they began at the same time. This conclusion was further confirmed in the report issued by the American College of Radiology, which is all the more significant because the ACR report, predictably, exonerated Saenger and his colleagues of any wrongdoing. The ACR report asserted, without apparently realizing the implications, that the cancer treatment program began in 1960, the same year the Pentagon support began. Thus, it seems clear that there was no such whole-body radiation treatment program at the University of Cincinnati Medical Center until the Pentagon contracted for one.

If cancer research had been the primary objective of Saenger's project, then there should have been a cancer study design at least as extensive as the design for the study of radiation effects. Yet the faculty committee announced:

> We have been unable to find any evidence of a planned, systematic cancer study. It seems unlikely that the team would not have mentioned, somewhere in the 900 pages of the Department of Defense (DOD) reports, the fact that they were conducting the DOD project in conjunction with a specific cancer research study, had this indeed been the case. Nor has the team made public, even during the recent months [of intensely unfavorable publicity], a design for cancer study in any way comparable to the detailed proposals for DOD radiation studies, proposals which have been repeatedly and painstakingly modified and amplified over the eleven years of the project.

The faculty committee noted that a number of the statements made by the Saenger team in its reports to the Pentagon "pointed clearly to the fact that the main reason for increasing the dose over the years was to improve the data—not on cancer treatment—but on radiation injury." For example, in their 1971 report to the Pentagon, Saenger and his colleagues stated:

> This [report] brings to 43 the total number of patients who have undergone assessment for the effects of total or partial body irradiation on their cognitive-intellectual functioning and emotional reactions. In terms of the characteristics of the overall sample, the addition of the new patients will serve to improve the ratio of whites to Negroes, to increase slightly the average educational attainment, and to decrease the average age. The trend noted in the 1969–70 report toward *recruiting patients in comparatively better physical condition has continued.* [Emphasis added.]

In all the years of the project, Saenger's team published absolutely nothing on their whole- or partial-body radiation program *as cancer treatment*. Yet there had been voluminous reports to the Pentagon on radiation injury. The faculty committee asked:

> Is it conceivable that in an authentic cancer research study, no results would be reported after eleven years and the irradiation of 87 patients? If no pattern had emerged after the irradiation of 87 patients—indeed after 10 or 20—would this in itself not have been worth communicating to other cancer specialists? . . . We can only conclude that the purpose of irradiating cancer patients . . . was primarily to study radiation injury for the Department of Defense and that incurable cancer patients were used because (a) they were going to die anyway and (b) they "might" benefit from the radiation in terms of reducing pain or slowing the spread of cancer.

Were the patients dying from the radiation rather than from their cancer? A strong indication is provided by the experience of the first 40 of Saenger's patients to receive whole-body radiation, 9 of whom died within thirty-eight days of treatment. Eighteen of these 40 patients received doses of 150 or 200 rads, and 7 of them, or 39 percent, died within thirty-eight days. The other 22 patients were given doses of 100 rads or less, and only 2 of them, or 10 percent, died within thirty-eight days. There could thus be little question that the higher doses had been much more lethal. The faculty committee stated: "It is perfectly clear that in the first six years of the project, the less radiation given, the better the patient was likely to do."

The faculty report offered further evidence that many of the patients had died from the radiation. One of the major means by which high doses of radiation cause death is by destroying the functioning of the bone marrow so that it can no longer produce blood cells. This problem usually begins about six days after irradiation and becomes critical between 25 and 40 days. The faculty report pointed out that it was exactly in this latter period that the nine patients had died—between 31 and 38 days. Furthermore, the reports of Saenger and his team were filled with descriptions of symptoms of bone marrow failure among these patients. In their 1966 report they stated that "severe hematologic [blood cell] depression was found in most patients who expired." In their 1963 report to the Pentagon they even wrote that "Delineation of disease score [a rating for the patients' blood problems before irradiation], radiation score [a rating for the blood problems after irradiation], and total continued to be of value in ascribing *the importance of radiation in precipitating demise.*" [Emphasis added.]*

What were the benefits that accrued to the patients from Saenger's treatment? The ACR report, which exonerated Saenger and his colleagues, stated that about one-third of the patients reported a decrease in pain and a greater "sense of well-being," and that one-third experienced a decrease in the size of their tumors. Saenger stated that he felt the statistics for long-term survivors—six patients lived several years after the treatments—would show that his methods were "promising." How Saenger was going to determine this was unclear, since many of the patients had received other kinds of therapy before or after the radiation. Furthermore, he had used no control group for comparison purposes.

Did Saenger and his team really inform these patients of the risks carried by his treatment, and did the patients give their consent? During the first five years of the project, no consent forms were used. In their reports to the Pentagon during this period, the team repeatedly stated that the patients were simply told they were receiving the treatment to help their sickness. In 1965 the team instituted a short consent form, which said nothing about specific radiation risks but merely stated that "the risks involved" and the "possibility of complications" had been explained and that "the special study and research nature of this treatment has been discussed with me and is understood by me." As the faculty report noted: "For what the patients were

*However, in a December 1971 report, issued in the midst of the controversy, Saenger stated that according to his interpretation of the data only eight of the total eighty-seven patients might have died from the radiation.

told we have only the doctors' word." A later form, used until the end of 1970, stated the risk as "the chance of infection or mild bleeding. . . ." This particular form began with the sentence:

> I (the subject) being of the age of majority and of sound mind and body, voluntarily and without force or duress, consent to participate in a scientific investigation *which is not directed specifically to my own benefit,* but in consideration for the expected advancement of medical knowledge, which may result for the benefit of mankind. [Emphasis added.]

In the spring of 1971, after the project had been discovered (but not yet exposed) by the journalist Roger Rappoport, a new consent form was initiated. This one included a long paragraph on bone marrow complications, and the initial sentence was altered to read: ". . . *not only* directed specifically to my own benefit, *but also* in consideration for the expected advancement of medical knowledge. . . ." After the scandal broke, only this last form was made public by University of Cincinnati officials, and the local press stated erroneously that it had been signed by every adult patient in the project. Regarding any or all of the consent forms used by Saenger and his team, the faculty committee commented: "In our view none of the consent forms properly states the real risk to the patients—that is, the risk of death from bone marrow failure within forty days."

The faculty committee report also pointed out some of the means by which the ACR had been able to arrive at its conclusion that the Saenger project was commendable. (The ACR, it will be remembered, is the organization which testified at the 1968 congressional hearings that there were no significant problems with the medical x-ray situation in this country.) For example, the ACR had simply left out of its report the complete statistics on patient survival. The only figures they gave were: "A group of 10 percent or eight patients died from 20 to 60 days after the whole-body exposure." But the faculty committee stated: "We find 14 total-body subjects who died within this period (not to mention 5 partial-body)—or 23 percent, and of course this figure takes no account of the 6 subjects who died within the first 20 days."

As for the question of whether Saenger's treatment was employed by any other medical institutions or if it had ever been used on paying patients, the ACR said that "some type of partial or whole-body radiation is used in more than 42 different U.S. medical centers." They did not identify any of these medical centers; nor did they specify whether this treatment consisted of hundreds of rads delivered in a half-hour to an hour. The ACR went on to say: "A total list of these institutions is not available, but they do include both public institutions . . . and private ones where most patients are charged for their care and treatment. Thus it is likely that instances could be found in which patients did pay for this treatment approach." But despite the avalanche of unfavorable publicity, the ACR couldn't cite a single one. The ACR warmly endorsed the experiments of Saenger and his team and urged that they be continued.

Presumably Saenger will also continue his studies of low-level radiation effects for the Public Health Service, studies which, of course, are helpful in his efforts as a national radiation protection official to ensure that no members of the public are ever overexposed to radiation.

Dr. LUSHBAUGH. Are you going to give Dr. Saenger equal time?

Mr. WALGREN. We will hold the record at this point for any submission you would want to make on that.

[Testimony resumes on p. 863.]

[The following materials were subsequently received for the record:]

UNIVERSITY OF CINCINNATI
COLLEGE OF MEDICINE

MAILING ADDRESS:
RADIOISOTOPE LABORATORY
CINCINNATI GENERAL HOSPITAL
CINCINNATI, OHIO 45267

May 9, 1978

Representative Paul G. Rogers
Chairman, Subcommittee on Health and the Environment
of the Committee on Interstate and Foreign Commerce
United States House of Representatives
Room 2415 Rayburn House Office Building
Washington, D.C. 20515

Dear Representative Rogers,

On January 12, 1978 I received a copy of a notice from the Office of the American College of Nuclear Physicians stating that certain hearings were being held by the Subcommittee on Health and the Environment on January 23-25, 1978 and that persons were to testify by invitation only.

Subsequently while teaching in the semi-annual course on Medical Planning and Care in Radiation Accidents at Oak Ridge, Tennessee on March 6, I was provided with copies of the transcript of the hearings. I find that beginning on page 5-152 through page 5-162 that Representative Walgren from Pittsburgh and Representative Carter made frequent references to me in connection with a recommendation by me of Mrs. Edythalena Tompkins of Oak Ridge, Tennessee to serve as an epidemiologist under the direction of Dr. Clarence Lushbaugh.

On page 5-159 lines 11 and 12, Representative Walgren states that the record will be held open for any submission which I would care to make on the several comments concerning my work and the references made to it by these two gentlemen.

Initially I should like to submit a curriculum vitae (attachment 1)* which states in detail all of my scientific work concerned with the safe use of radiation in medical and allied fields. I would particularly like to point out the fact that I have served as Chairman of two Scientific Committees of the National Council on Radiation Protection and Measurements (NCRP) which have published Reports 40 and 55 following extensive critical review by at least 60-65 scientists who are members of the NCRP and by numerous other agencies within government.

Further I wish to point out that my handbook, "Medical Aspects of Radiation Accidents", is the first text of its kind published anywhere in the world which had to do with the protection of human beings from the effects of radiation both from external sources and from radioactive substances under accidental circumstances. In addition there are a number of epidemiological studies which have been widely cited throughout the scientific and medical literature.

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*May be found in the subcommittee file.

In my epidemiological work I directed and was a senior author of one of the original studies pointing out the relationship of the development of thyroid cancer in children and young adults to prior irradiation of the head, neck and chest for non-malignant conditions, a type of therapy utilized prior to the advent of antibiotics for the treatment of infections. In addition, I have served since 1960 as the Chairman of the Isotope Committee and subsequently as Chairman of the Radiation Safety Committee of the University of Cincinnati and as such administer the radiation safety program which has been found to be exemplary both in its reviews by the Atomic Energy Commission, the Nuclear Regulatory Commission and other accrediting agents to the Hospital and College of Medicine of the University of Cincinnati. In these latter regards it continues to be my firm intent to avoid increasing the risks of these young people who train under me as well as patients to ionizing radiation and the diseases which have been associated with doses of any order of magnitude to these agents.

Turning now to the citations of Representatives Walgren and Carter from a book entitled "Silent Slaughter" I would like to first point out the number of scientific papers from our Laboratory describing in considerable clinical and scientific detail the studies which were performed as part of a therapeutic attempt to control far advanced cancer in a group of patients in whom curative efforts for the most part were not considered to be possible (attachment 2). We utilized the most carefully constructed informed consent then or now utilized in the United States to obtain the complete understanding of patients and their families for our work. The degree of cooperation on the part of our patients was demonstrated by the fact that none of the patients or their families in this program were willing to testify against us when called upon to do so by staff assistants of one legislator some years earlier. The entire project was reviewed by a committee of the American College of Radiology, a copy of which report is appended (attachment 3). In addition the GAO found after a complete search of all financial transactions between the University of Cincinnati and the United States Government that none of the monies which were given to us for scientific research through our Department of Defense (DOD) contracts were at any time used for direct patient care or to encourage in any way the involvement of patients in these studies.

Turning now to the specific statements of Representatives Walgren and Carter concerning the work which I directed from 1960 to 1971, the citations developed in the record were apparently taken from a book entitled "Silent Slaughter" written by Joel Griffiths and Richard Ballantine and published by Henry Regnery and Company of Chicago in 1972. In contrast with the refereed works in accepted scientific journals cited above, it is interesting that anonymity is requested by various individuals who contributed comments to these authors as stated on the Acknowledgement Page (attachment 4).* The statement is in direct contrast to the policies of scientific journals in which instances the papers are reviewed by knowledgeable scientists selected by the editor following which review the editors assume responsibility for the papers accepted by them for publication. In addition these scientific journals have publications committees who review the work of the editors.

We have tried through accepted library methods to elicit the qualifications of Messrs. Griffiths and Ballantine in regard to their scientific competence to write such a tract and have been unable to find any material referring to them either in American Men of Science, Directory of Medical Specialists, Who's Who either in the United States or in subdivisions thereof, or other reference works which describe professional people including journalists.

Since the publication of this document, I have been requested in 1976 to review the subject of total body irradiation at the XIV International Radiological Congress held in Brazil in October of 1976. Unfortunately at that time illness prevented me from presenting the paper but the paper has been prepared and a copy of this document is attached (attachment 5). Of particular interest to the members of your Committee should be the fact that total body and partial body irradiation although having been employed for many years in the treatment of various cancers is now more widely used than ever both in the treatment of leukemia and lymphoma but also in the treatment of certain solid tumors such as cancer of the lung, large bowel and others. These citations from refereed medical journals are included in the bibliography of attachment 5.

I would not like to imply that the increase in the utilization of these methods of treatment was a result of our researches but certainly our researches may have been of some help in the wider utilization of these methods.

For the several reasons stated above it is somewhat difficult for me to accept the statement of Representative Walgren on page 5-157 that my experiments read like something out of Frankenstein. A similar statement on page 5-160 line 9 compares our work to something done by Dracula.

In regard to Representative Walgren's comments on page 5-156 concerning deaths of persons in the nuclear industry from high radiation levels it should be pointed out that these deaths have been far less than those experienced in any other industry in the United States. Again in regard to the statements of Representative Carter on page

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*May be found in the subcommittee file.

5-160 I should like specifically to direct his attention to the more recent publications on the use of total body irradiation and partial body irradiation as cited in the published references listed in (attachment 5). My only purpose in enclosing this attachment is to include the bibliography which I am sure due to the pressure of his many commitments in the House of Representatives he is unable to extract from the medical and scientific literature.

It is my earnest hope that this letter and attachments will clarify to some extent the statements made in this particular hearing especially in regard to Mrs. Edythalena Tompkins. This particular discussion seems a rather peculiar way to determine the creditability of an individual who has conducted herself with the highest scientific principles and ideals.

In regard to the substantive issues of the hearings there have been two exhaustive reviews of radiation risks and standards published in 1977. One of these is by the International Commission on Radiation Protection (ICRP) Report 26, "Recommendations of the International Commission on Radiological Protection" an international scientific and standard setting agency concerned with radiation safety. In spite of statements made to your Committee, ICRP 26 does not recommend any change in standards either for workers or the public.

A second document, the 1977 UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation) report, is a voluminous document of some 725 pages and contains 3163 references. In none of the papers dealing either with genetic risks of radiation or somatic risks of radiation particularly those of carcinogenesis are any of the data or statements of Dr. Mancuso in regard to the health of the U.S. atomic energy workers, of Karl Z. Morgan, Ph.D., of Ernst Sternglass, Ph.D., or of Irving Bross, Ph.D. cited. The only work of Dr. Alice Stewart which has been cited was her early work in regard to malignancies in children as mothers received irradiation during the period of pregnancy.

The import of these statements is the fact that those published papers of the authors just cited and scientific data available through AEC or ERDA reports of Dr. Mancuso were all available to the UNSCEAR Committee who developed the 1977 report. In common with the 3163 references it is significant, at least to many scientists and physicians, that the testimony given such publicity before your Committee did not appear to be utilized by these experts from all over the world. Again one should inquire what particular soul saving mission is held by these individuals in contrast to those of us in responsible positions in university medical centers and within the international community which can produce a degree of unanimity of thought not shared by the men who are invited to appear before these hearings. It would be my personal hope that a somewhat less impassioned and better qualified group of experts be requested to offer testimony during similar inquiries which will undoubtedly be held in the future.

On several occasions over the past few years I have urged the several responsible agencies of the Federal Government first to coordinate and then to expand the epidemiological studies involving possible effects of exposure to low doses of radiation. The type of interagency and indepartmental attack on this problem of effects of low dose exposure utilizing as well scientists from the academic sphere has not been implemented in a properly designed way.

The determination of the relation of radiation exposure to troops at the Nevada test site or other sites of weapons testing or of workers in Naval installations in the United States are properly the subject of continuing, properly designed and evaluated epidemiological studies. In this regard I want to cite the statement from the UNSCEAR report concerning the proper design of the epidemiological studies, a study in which Mrs. Tompkins and I were principal authors (UNSCEAR 1977, page 367, item #40).

It is my understanding that those individuals who file claims with the Veterans Administration have been compensated and at least they have been offered some compensation for a disease which may or may not have been related to service to the United States government. If their sacrifice proves to be sufficiently associated with radiation to set new standards, remains to be determined by the scientific community. If, on the other hand, it would develop that they and such other individuals as may have contracted these unfortunate diseases may have had contact with other carcinogenic agents or that these episodes might represent a clustering of these diseases as recently occurred in New Jersey and some years ago in Niles, Illinois, then such facts should be determined before it is decided to make changes in standards which up until now have been regarded as being satisfactory for the widespread use of radiation in medicine, industry and for nuclear energy.

Sincerely,

Eugene L. Saenger

Eugene L. Saenger, M.D.
Professor of Radiology
Director, Radioisotope Laboratory
Vice-Chairman, Department of Radiology

ELS/swh

REFERENCES

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WHOLE BODY AND PARTIAL BODY RADIOTHERAPY OF ADVANCED CANCER*

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THE purpose of these investigations has been to improve the treatment and general clinical management and if possible the length of survival of patients with advanced cancer. Systemic effects of radiation therapy have been given particular attention in our work.

In the period February 19, 1960, through August 31, 1971, 85 adults were given whole or partial body radiation as therapy for far advanced cancer.

This paper will report on the survival of patients in 3 categories: colon; lung; and breast.

Prophylactic whole body radiation therapy was given to 3 children with localized Ewing's sarcoma and this experience will be discussed briefly.

Investigations of biochemical, cytologic and psychologic tests have been reported elsewhere.[8,11,30]

Our experience with the adjuvant use of autologous bone marrow will also be described.

ANIMAL STUDIES

The animal investigations basic to our work stem from the studies of Hollcroft *et al.*[13–15] These authors demonstrated better tumor regression when whole body irradiation was preceded by localized radiation therapy than when localized radiation therapy was given alone both for lymphoma and carcinoma in mice. The studies of Jacobson *et al.*[18,19] showed the importance of shielding of the spleen and other organs and parts of the body in preventing high dose radiation lethality in the mouse.

BRIEF REVIEW OF TOTAL BODY IRRADIATION IN MAN

Total body irradiation was first employed in 1923 by Chaoul and Lange.[7] Its use in 270 cases over the next 20 years was reviewed by Medinger and Craver.[22] These authors found the greatest palliation in the lymphomas and myeloproliferative diseases, but also noted improvement in multiple myeloma. Thirty-five patients with advanced carcinoma or sarcoma were included in this series, most of them receiving their total body radiation between 1931 and 1933.

Loeffler *et al.*[20] compared total body irradiation in single doses up to 150 r with nitrogen mustard and triethylene melamine and found that neither chemotherapy nor radiotherapy differed in hematologic effects, but that the patients receiving radiation did not experience the malaise of varying severity noted by all patients receiving the chemotherapeutic agents. Subjective improvement was noted only in the radiotherapy group.

Collins and Loeffler[9] gave total body irradiation in single exposure up to 200 roentgens and found this form of systemic therapy "a useful addition to the management of advanced cancer." The malignancies treated included lymphoma, chronic

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* Presented at the Seventy-third Annual Meeting of the American Roentgen Ray Society, Washington, D. C., October 3–6, 1972.
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myelogenous leukemia and multiple myeloma.

Interest in total body irradiation in the treatment of Ewing's sarcoma, a tumor of children which carries a high mortality, has been aroused by reports from Milburn *et al.*,[34] Jenkins *et al.*,[21] and Rider and Hasselback.[39] In a small series so treated, survival appeared to be moderately improved compared to larger series treated by conventional local radiotherapy and/or ablative surgery. These groups felt further evaluation of this form of therapy to be most important.

Additional data have been published by the Medical Division of Oak Ridge Associated Universities,[1] concerning total body radiation therapy of lymphoproliferative and myeloproliferative disease.

Summaries of the frequent use of total body irradiation for the therapy of leukemia appear in an article by Buckner *et al.*[4] and in a comprehensive review of bone marrow transplantation by Bortin.[3]

Whole body radiation in routine clinical therapy has been and is currently used for leukemia,[23,53] lymphoma,[22–26,53] Hodgkin's disease,[8] polycythemia vera,[5] cancer of breast,[31] cancer of thyroid,[6] cancer of prostate,[10,31] and multiple myeloma.[9,32] Such therapy may be given by external radiation therapy (as in this particular study) or in the form of various radionuclides.

STUDY DESIGN

The studies reported here were initially considered as being in Phase I (to determine whether the treatment was toxic or not) and subsequently as Phase II (whether treatment appears effective or not but without controls). In reviewing these data it has been possible to find some comparable material in the literature. In one category, cancer of bronchus, comparable data were available in our institution.

INFORMED CONSENT AND INSTITUTIONAL REVIEW

All patients gave informed consent in accordance with directives of the Faculty Research Committee of the University of Cincinnati College of Medicine and those of the National Institutes of Health. The use of formal informed consent forms in this study antedated the above requirements by 2 years. The project is reviewed and approved regularly by the above Committee.

ELIGIBILITY OF PATIENTS

Patients become eligible for this form of treatment if they have advanced cancer for which cure could not be anticipated. Three children with localized Ewing's tumor at Children's Hospital were given whole body radiation as part of the curative attempt after the primary tumor had been ablated with local radiotherapy.

Biopsy proof of the malignancy has been established in all instances. Clinical data in each case have been reviewed by several physicians to be certain that the tumor had indeed extended from its primary site and that curative therapy was not applicable. This preliminary evaluation is followed by an observation period of 7–14 days to observe the general condition of the patient and to carry out baseline laboratory tests to be as certain as possible that the condition of the patient is relatively stable. Frequently this determination is difficult since the patients have serious illnesses of long standing and often have had considerable previous therapy.

Patients remain in the hospital as long as is necessary. Prior to the use of autologous bone marrow transfusion, hospitalization was occasionally as long as 8–10 weeks. Length of stay was also dependent upon the severity of the clinical manifestations stemming from the cancer. With the use of partial body irradiation and bone marrow infusion, hospitalization has been greatly shortened. The follow-up procedure is continuous during the lifetime of the patient.

A total of 112 subjects were initially entered in the study through August 31, 1971. During the screening period of 7–14 days, 24 of them (21 per cent) were not continued in the study and did not receive whole or partial body irradiation. Chief among the reasons for elimination was an indication in the pretreatment phase that some risk from wide-field radiation might ensue or that another method of treatment was considered preferable. In some, a very rapid progress of the disease made inclusion undesirable. The treatment was completed in 85 adults and 3 children between April 1960 and August 31, 1971. Three patients have received 2 separate courses of treatment in this program. Follow-up time for survivors is reported through August 31, 1972.

PATIENT DOSIMETRY

The radiation is delivered by a cobalt 60 teletherapy unit under the following exposure conditions: The beam is directed horizontally at a wall 342 cm. away with the midline of the patient at 286 cm. from the source. For whole body exposures, the radiation beam size for the 60 per cent isodose curve at the patient midline distance is a square approximately 120 cm. × 120 cm. The patient is placed in the sitting position with legs raised and head tilted slightly forward. Radiation is given by delivering half the specified exposure laterally through one side of the patient, the patient is then turned and the other half exposure delivered laterally through the other side. The combined dose of the 2 radiation fields provides a good homogeneous dose distribution through the patient. The maximum variation in lateral dose distribution was ±13 per cent for 1 patient who had a lateral trunk dimension of 36 cm.

The exposure to the patient is determined using a percentage depth dose table corrected for the source-to-skin distance used for the patient. Using the corrected depth dose at patient midline (1/2 lateral dimension at the trunk in the plane of the xiphoid) and a conversion factor of 0.957 rads/roentgen for cobalt 60 gamma radiation, the midline air exposure required to give a desired midline absorbed dose in rads is calculated. The validity of this procedure was established with measurements in an Alderson Rando Phantom using thermoluminescence dosimeters. Over the course of the study, the air exposure rates at the distance indicated above varied from 3 to 6 per minute.

For individuals receiving partial body radiation, the teletherapy collimator is used to restrict the beam. The xiphoid is used as the boundary of the field for upper and lower body exposures. The lateral dimensions of the patient in the plane of the xiphoid is again used for calculating the desired midline dose. As for the whole body exposure, the dose is delivered bilaterally. Additional information on the dosimetry aspects of this study has been published by Kereiakes *et al.*[17]

ANALYSIS OF SURVIVAL DATA

In considering the survival data there was a lack of consistent selection bias both in recommendation that a patient be eligible for treatment and in regard to the dose. The principal investigator had no part in determination of therapy in any given case except for outlining the general principles of the therapeutic regime. The choice in the case of each patient was made by several radiation therapists, 3 having been associated with the project during the 10 year period. In addition, 2 internists have had active roles in the selection and medical care of each patient. The dose of radiation to be given was decided upon by the radiation therapist in consultation with the internist.

There are 3 categories of patients (those with carcinoma of the colon, lung and breast) which are large enough to permit some analyses of survival. Each group will be discussed separately.

Survival data are given in days from the diagnosis of far advanced disease, since this convention has been used frequently in the literature and permits comparison of our survival data with published reports.

CANCER OF THE COLON AND RECTUM

Twenty-nine patients with this tumor comprised the largest single category (Table 1). In all cases the patients were classed

TABLE I

CANCER OF COLON—ALL CASES BY LENGTH OF SURVIVAL OF ADVANCED DISEASE

(29 Patients)

Study No.*	Age	Sex/Race	Survival After D_x (days)	Survival After R_x (days)	Dose† (rads)
106	58	F /W	40	25	300 LB
109	56	M/W	116	80	300 LB
052	60	M/W	120	91	200 LB
033	64	M/N	126	86	100
082	49	F /N	136	33	300 LB
015	61	M/N	143	32	100
007	62	M/N	181	121	100
067	52	F /N	192	163	100 LB
049	75	M/N	213	169	200 LB
050	80	M/N	220	197	200 UB
036	64	M/N	261	238	100
064	54	F /N	262	188	300 LB
091	62	F /W	295	52	200
063	38	M/W	299	244	300 LB
066	63	M/N	327	203	200 LB
107	58	F/W	347	89	200
047	57	M/W	411	147	150 LB
111	52	F /N	434	307	200
062	60	M/N	451	270	150
096	42	M/N	583	439	100
113	72	F /N	632	381	100
098/103	45	F /N	912	474	200+300 LB
020	69	F /N	946	885	200
006	67	M/W	982	740	54
101	76	M/N	983	864	257 LB
100	76	M/N	1,258	900	300 LB
023	44	M/N	1,261	651	200
095/104	66	F /N	1,437	704	200+300 LB
108	66	F /W	1,691	584	300 UB

* Study No. refers to the roster of patients described serially in Technical Reports: No. 6–15[40], 18–29[41], 31–36[42], 6–64[43], 66–70[44], 77–82[45], 83–91[46], 92–103[47], 104–111[48], 112–113 personal communication.[ELS]

† Dose in rads at the midline. Where no letter follows the dose, whole body radiation was given. LB = lower body irradiation; UB = upper body irradiation. The dividing point is the xiphoid.

Median survival—327 days.

as far advanced and in a few instances as terminal. Four patients were not included in the study for medical reasons, or because the patients themselves declined participation in the study.

In order to make an appropriate comparison, several published series were reviewed. Series of cases of colon cancer metastatic to liver were utilized, since they were the best found by us with appropriate time periods of metastasis available for comparison. Stearns and Binkley,[51] in 32 patients with colon cancer with liver metastases, found a median survival time of 11 months after palliative resection of the primary tumor; in 28 of their patients in whom only biopsy or diversion was performed, the median survival was 8 months. In 353 patients with untreated colon cancer metastatic to liver, Pestana *et al.*[37] reported a median survival of 9 months. Figure 1 presents an analysis of 177 patients with liver metastases and no subsequent therapy reported by Jaffe *et al.*[30] There is also a group of 61 patients reported by Rapoport and Burleson[38] treated with 5-fluorouracil.

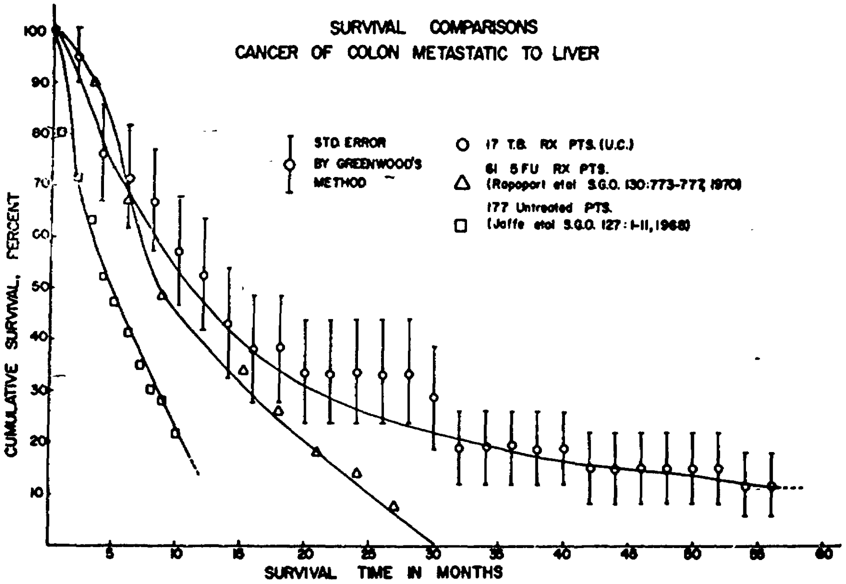

FIG. 1.

The 22 patients in our series with proven metastatic carcinoma of the colon to the liver treated by irradiation are also shown in Figure 1.

The median survival time for untreated patients was 146 days; for patients treated only with 5-fluorouracil, 255 days; and, among our patients with liver metastases, 391 days (Table II). A life table analysis was performed and indicates that the treatment given to our patients was approximately equivalent to the group given 5-fluorouracil. There was no evidence that the median survival time was shortened by total or partial body irradiation (Fig. 1). It should be appreciated that 5 of our patients had received or are receiving 5-fluorouracil in addition to the radiation therapy (3 of these with liver metastases).

The median survival for the entire group of 29 patients (22 with liver metastases) was 327 days.

CANCER OF THE BRONCHUS

This group of 15 patients (Table III) had far advanced disease with distant metastases at the time of treatment. The best comparison group was from our own institution reported by Horwitz *et al.*[16] The median survival of the 15 patients receiving whole body irradiation was 193 days from the time of diagnosis. The median survival of 61 patients seen at Cincinnati General Hospital from December, 1961, to June, 1964, was 135 days. In 15 of the 17 cases with distant metastases excluded by Horwitz *et al.* from their study (see caption to Fig. 2), the median survival was 32 days.

This last group of patients with distant metastases constitutes the most appropriate comparison group. When the median survival* of 15 patients mentioned by Horwitz *et al.*[16] is compared with the 15 patients treated by whole body irradiation; the survival times are significantly different (Chi square 11.63, $p<0.005$) (Fig. 3).

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* Two of the 17 patients excluded in the Horwitz *et al.*[16] study were treated by whole body radiation.

EWING'S TUMOR

This subgroup of 3 patients constituted the only one in which an attempt at curative therapy was made; all 3 patients are surviving. The times of survival are 854, 1,243 and 1,553 days from the time of diagnosis to August 31, 1972. The patient with the longest survival has recently developed a solitary pulmonary metastasis. The use of whole body irradiation to eliminate small clumps of cells in the disease has been reported by others.[21,33]

A fourth patient with Ewing's tumor had pulmonary metastases when first seen. Therapy in that case was only palliative.

TABLE II

CANCER OF COLON—CASES WITH METASTASES TO LIVER

(22 Patients)

Study No.*	Survival After D_x (days)	Survival After R_x (days)
106	40	25
109	116	80
052	120	91
033	126	86
082	136	33
015	143	121
067	192	163
036	261	238
091	295	52
066	327	203
107	347	89
111	434	307
062	451	270
096	583	439
113	632	381
098	912	474
006	982	740
101	983	864
100	1,258	900
023	1,261	651
095	1,437	704
108	1,691	584

* See footnote to Table 1.
Median survival—391 days.

TABLE III

LUNG CANCER—SURVIVAL IN DAYS AFTER D_x

(15 Patients)

Study No.*	Survival After D_x (days)	Survival After R_x (days)	Dose (rads)
053	57	28	200
056	103	38	100 UB
086	116	20	100
078	126	61	200
088	135	7	150
081	144	24	100
051	163	74	150
070	193	68	150
102	266	22	200 Trunk
018	333	298	200
044	349	196	100
011	419	323	100
112	683	403	100
025	797	33	150
084/097	855	643	300 UB+100

* See footnote to Table 1.
Median survival—193 days.

CANCER OF THE BREAST

In 15 cases treated by us the median survival from diagnosis to death was 479 days and after treatment to death was 446 days (Table IV). Two comparable reports in the literature include the one by the Committee on Estrogens and Androgens[33] and the other by Samp and Ansfield using 5-fluorouracil.[49] Again a life table analysis was done for our 15 patients and indicates that the survival of our patients appears somewhat better than that of the patients treated solely by estrogens and androgens, but not quite as good as the group treated with 5-fluorouracil (Fig. 4). The patients survive longer than those receiving the "standard therapy" as described by Samp and Ansfield;[49] this includes appropriate administration of estrogen and androgen, oophorectomy, local irradiation, adrenalectomy and hypophysectomy.

OTHER CANCERS

A remaining group of 25 cases reflected several different kinds of cancer. It is not

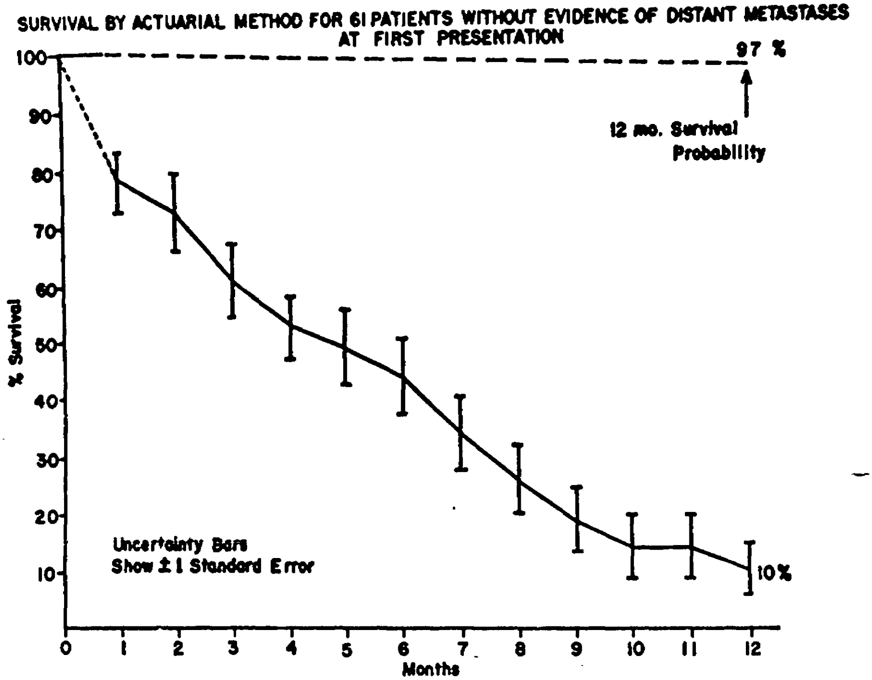

FIG. 2. The survival by actuarial analysis is shown for a total of 61 patients with carcinoma of the bronchus and distant metastases, who presented between December, 1961 and June, 1964 at Cincinnati General Hospital. The only patients excluded from this group are those in whom distant metastases were present at the time of diagnosis (17 patients). If they were to be included, the 1 year survival figure would drop to about 7 per cent. It is emphasized that these figures take account of all cases seen (including those apparently "early" and amenable to complete surgical resection). Although other reported figures may be somewhat higher, differences are more realistically attributable to biologic factors rather than to therapy.[16]

possible to make an analysis of these at this point since the individual case groups are too small to warrant this

DISCUSSION

RELATION OF RADIATION THERAPY TO PATIENT DEATH

Some analyses can be made which give information on this point.

The doses of whole body radiation given could initiate only the hematologic form of the acute radiation syndrome. In the healthy individual, after prodromal symptoms of malaise and vomiting lasting about 6–48 hours, there is a latent period lasting until 18–21 days after exposure. At this time there is a marked rapid fall in white blood cells and platelets and a less rapid fall of red blood cells reaching a nadir at 30–40 days and then recovering. These changes are associated frequently with episodes of infection and bleeding. Epilation will occur at doses over 300 rads.

Many of these patients had received much radiation and chemotherapy prior to total or partial body treatment and in

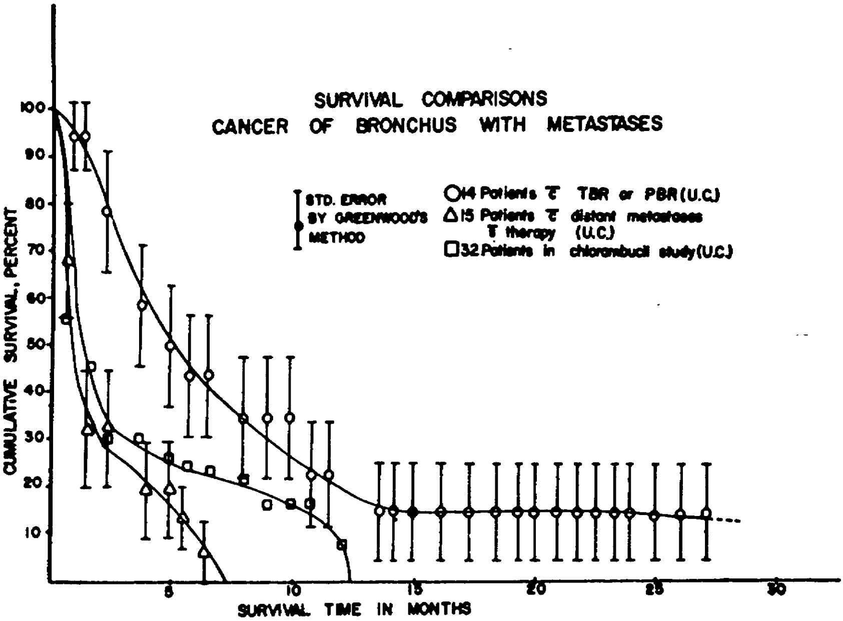

FIG. 3.

many cases this treatment was followed immediately by planned local therapy to various portions of the body.

If one assumes that all severe drops in blood cell count and all instances of hypocellular or acellular marrow at death were due only to radiation and not influenced by the type or extent of cancer and effects of previous therapy, then one can identify 8 cases in which there is a possibility of the therapy contributing to mortality. Of this subgroup, 2 patients received localized radiation between total body irradiation and death at 31 and 32 days, respectively. Two had extensive previous chemotherapy and 1 also had local radiotherapy. In 2 other cases, autologous marrow transfusion was unsuccessful because the preradiation marrow was hypocellular. Both of these latter patients had had intensive localized irradiation and 1 had received intensive chemotherapy.

TABLE IV

CANCER OF BREAST—SURVIVAL POST D_x

(15 Patients)

Study No.*	Survival After D_x (days)	Survival After R_x (days)	Dose (rads)
089	101	16	200 Trunk
055	175	156	200 UB
029	285	152	150
060	316	30	150
045	138	25	150
022	473	10	150
094	473	354	150 Trunk
031	479	446	100
079	554	209	100
010	783	48	100
008	1,056	91	100
035	1,068	859	150
040	1,095	1,063	100
083	1,098	264	100
092	1,308	1,143	150 Trunk

* See footnote to Table 1.
Median survival—479 days.

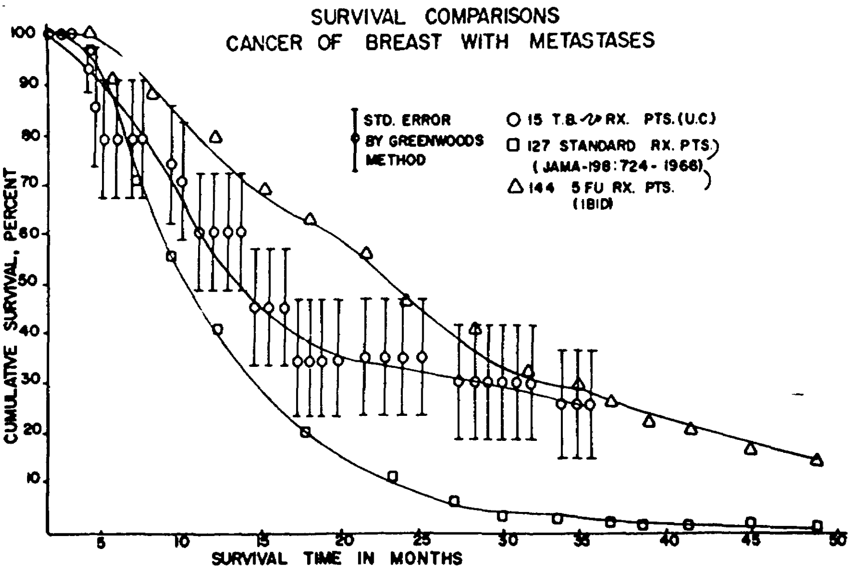

FIG. 4.

Of the 19 patients who died within 20–60 days, 11 showed clear evidence of well functioning marrow with steady or rising white blood cell counts and absence of bleeding and infection at the time of death.

The time from diagnosis to death of the 24 patients entered in the study who were not treated has been analyzed. There were 4 who died in a 20–60 day interval:

	No. of deaths in 20–60 days	*Patients surviving or dying at other times*	*Total*
Patients not given radiation	4	20	24
Patients given radiation	19	63	82

Fisher's exact probability test yields a p value of 0.16, indicating that there is no difference between the 2 groups. Therefore one may conclude that in other patients described, the effect of whole and partial body radiation therapy was less important in contributing to death than was the extent of disease in these patients. Another interpretation would be that a physician selecting far advanced cancer patients for a given treatment would have about the same degree of difficulty in selecting any form of treatment for these very ill patients. The same probabilities, $p=0.19$, 0.2 and 0.21 are found for patients dying between 0 and 20 days post treatment, from 0–60 days, and from 20–40 days, when compared to the untreated group. Current status of survival for these 88 treated patients is as follows:

Prophylactic therapy (Ewing's tumor)	3
Others surviving as of August 31, 1972	7
Deaths possibly attributable to irradiation	8
Deaths attributable to tumor	70
	88

REACTIONS FROM TREATMENT AND EFFECTS OF PALLIATION

The acute radiation syndrome develops in stages. In the prodromal stage, nausea and vomiting of a transient nature occur.

These complaints are often highly subjective; therefore, they are not discussed with the patient before treatment.

The analysis of our 88 treated patients shows that 44 per cent experienced no symptoms at all, that 27 per cent had transient nausea and vomiting within 3 hours, 14 per cent within 6 hours and 3 per cent within 12 hours. In only 4 patients (4 per cent) were the nausea and vomiting of a severe nature (Table v).

These symptoms are no greater than found after surgery or after treatment with cancer chemotherapy drugs, the reactions of which are often far more severe than those from these kinds of radiation therapy. Lahiri *et al.*[19] observed that when 5-fluorouracil is given orally at a dose of 15 mg./kg. daily for 6 days, and then weekly at the same dose, nausea, vomiting, diarrhea or stomatitis are found in 55 per cent of the patients treated, and marrow depression is observed in 50 per cent. A recent study by the Western Cooperative Cancer Chemotherapy Group, employing 5-fluorouracil without a loading dose at 15 mg./kg./wk. for a month, reported mild to major gastrointestinal or hematologic toxicity in 85.5 per cent of 430 patients.[17] Higgins *et al.*[12] in treating cancer of the colon using 12 mg./kg. of 5-fluorouracil intravenously for 5 successive days, observed that 27.9 per cent of 359 patients experienced a toxic reaction. The same group reported one or more surgical complications following resection of colon carcinoma in 29.6 per cent of 433 patients. Parsons *et al.*[15] note that 61–72 per cent of patients suffering from so-called radiation sickness responded favorably to placebo medication, indicating that suggestibility may have a big part to play in the appearance and control of these symptoms. Mukherji *et al.*[14] in evaluating the effectiveness of a combination of 4 drugs in the treatment of 23 patients with lymphosarcoma and reticulum cell sarcoma found severe myelosuppression in 4 patients (17 per cent) and possibly attributed this depression to their deaths from infection.

TABLE V

INCIDENCE OF NAUSEA AND VOMITING IN 88 CANCER PATIENTS RECEIVING WHOLE AND/OR PARTIAL BODY RADIATION THERAPY

	Patients	Per Cent
No nausea or vomiting	39	44
Nausea and/or vomiting up to 3 hours after R_x	23	27
Nausea and/or vomiting up to 6 hours after R_x	12	14
Nausea and/or vomiting up to 12 hours after R_x	3	3
Nausea and/or vomiting up to 24 hours after R_x	7	8
Nausea and/or vomiting up to 48 hours after R_x	0	—
Nausea and/or vomiting 48 hours +	4	4
	88	100

During the latent period of 18–21 days the patient is asymptomatic. The period of manifest illness then begins with evidence of malaise, infection and bleeding. These findings occur only with whole body irradiation and not with partial body treatment. Also when marrow is successfully replaced these findings do not occur.

In regard to palliation, a review of patient records shows that some palliation was achieved in 56 per cent and that 31 per cent were made neither better nor worse (Table vi). In another 3 cases we were unable to obtain follow-up history concerning palliative effects. The 3 cases of Ewing's tumor are not included in this table as therapy was prophylactic.

POSSIBLE UNIQUE MECHANISMS OF WHOLE AND PARTIAL BODY IRRADIATION

Whole body irradiation in the doses reported herein could be effective against cancer in several ways: (1) alteration of the immune mechanism of the body altering the balance in favor of the host; (2) by a direct effect on the metabolism of the cancer cells. In this case wide-field radiotherapy would have one advantage over drug therapy, since it would reach all cancer cells without depending upon blood

TABLE VI

PALLIATIVE EFFECTS* OF TREATMENT

(85 Patients†)

	Per Cent
Relief of pain	31
Decrease in tumor size	31
Increase in activity	13
Increase in well being (weight gain, appetite improvement, subjective statement by patient)	30
One or more of the above	56
No change	31
Lost to follow-up for evaluation of palliation	4
Death between 20 and 60 days possibly attributable to radiation	9

* In some of the patients there was more than one indication of improvement; thus, the percentages exceed 100 per cent.

† 3 children with Ewing's tumor received prophylactic treatment and are not included in this analysis.

supply, or chemical and pharmacologic distribution.

Partial body irradiation could be compared to regional isolation perfusion with antineoplastic drugs, again being certain to reach all tumor cells within the irradiated volume and lacking the more hazardous systemic effects of total body irradiation.

The effectiveness of both methods may be explained by the fact that small tumor foci are more sensitive to treatment than large foci and that single cancer cells are more susceptible than clumps of cells.

PSYCHOLOGIC AND PSYCHIATRIC EVALUATION OF PATIENTS

A unique and important aspect of the research work in this project has been the attempt to evaluate and distinguish between the manifestations of cancer and the effects of radiation therapy in regard to psychologic and psychiatric changes. For example, others have reported on personality types in certain cancers,[2] but no studies were presented investigating the effects of treatment.

In 1969, we reported on the effect of total and partial body irradiation on the cognitive and emotional processes of 16 patients.[11] This number has been increased to 43. These studies consisted of administration of a battery of tests to each patient in the pretreatment phase, during sham and actual treatment and during a 6 week post-treatment period. Tests which have been utilized included the Halstead Battery, Wechsler-Bellevue Adult Intelligence Scale, some tests of intellectual impairment modified from Reitan, and the 5 minute verbal content test of Gottschalk and Gleser. There has been some change in the several tests which we have been using during this phase of the total project; *i.e.*, not all tests have been used continually.

In the baseline data of 39 patients tested, the median intelligence quotient was 87 and the mean also 87. There were 41 per cent of subjects with I.Q. values of 95–116, 47 per cent between 71–95, and 12 per cent between 63–70. The distribution of intelligence factors as measured by several tests is representative of the population served by the General Hospital.

It is clear that the intensive study and the above testing have had a helpful effect in increasing the level of motivation to cooperate, as exhibited by all patients so studied.

The need for careful handling of the cancer patient by all members of the medical team is emphasized by the consistent evidence of depression over the 7 week study period. The depression is lessened with clinical improvement and attention to patient needs. It is also less in patients with long survival (over 100 days) as would be expected. Similarly, hope is directly related to survival. Anxiety dips sharply during sham treatment; it increases just prior to actual treatment, then decreases and levels off. Outward hostility tends to increase at the time of post sham treatment, then dips and remains quite stable. Hope as measured by the content analysis of verbal behavior is related to satisfactory human relations in the patient's life situation.

USE OF AUTOLOGOUS BONE MARROW TRANSPLANTATION

Because of radiation-induced hematologic depression, autologous bone marrow storage and reinfusion were instituted in 1964. Employing the method of Kurnick,[38] marrow was removed from the posterior iliac crest under local anesthesia, to an average value approximating 300 cc. It was mixed with Osgood-glycerol medium and stored at −83° C. following a programmed temperature reduction of 1° C. per minute. Prior to reinfusion dextrose was added, and then the marrow was given intravenously, initially without filtration, at a rate of 50 to 60 cc. per minute. The first 2 patients who received a marrow transfusion in our study, Patients 051 and 053, were infused with frozen marrow 24 and 19 days post irradiation, respectively, at a time when the marrow sinusoids were relatively empty of precursor cells, with the expectation that there would be more room for the transplant to take. Marrow viability in these 2 procedures was 55 and 57 per cent.[41]

Patient 051 experienced moderate hemoglobinuria not seen in Patient 053 after infusion. Marrow was given in both cases 2 to 3 weeks post irradiation; hence, it was impossible to distinguish spontaneous marrow recovery from successful marrow autotransfusion.

Because hemoglobinuria had been noted, a triple filter system was developed and marrow autotransplantations on Patients 070, 077, 078, 087, 090, 091, 095, 098, 099, 107 and 111 have all been performed employing this filter system.[48]

In marrow transplants of Patients 070, 077, and 078, the delay between the removal of marrow and transfusion was 11, 2 and 0 days, respectively. The platelet count of Patient 078 never fell below 125,000 per mm.^{3}, but the white blood cell count dropped as low as 900, suggesting possible effectiveness of the technique for the first time.

For the next 8 patients the technique was therefore modified, so that a larger volume of marrow (500 cc.) was removed from the patient under general anesthesia. The patient was then irradiated and the marrow replaced intravenously on the same day as it was removed. The results in Table VII indicate the success attendant on the modification of this procedure. Five patients receiving 200 rads of whole body radiation showed mean white blood counts to be 2,820 ± 804 cells per mm.^{3} at the nadir. In 7 patients given the same dose but no autograft, the level at the nadir was 850 ±380 cells per mm.^{3}, the 2 means being significantly different (Table VIII). The first patient transplanted with our new technique (Patient 087) was followed in the Clinical Research Center, Cincinnati Children's Hospital, for over 6 weeks without any evidence of illness. Subsequently patients receiving these whole body doses have only been hospitalized for a total of 5 days or less. The degree of marrow depression in the successfully transplanted patient is such that hemorrhage and infection are not observed.

The 3 failures in the revised transplantation technique have been Patient 090, 099 and 107. Patient 090 suffered a cerebrovascular accident unrelated to her tumor or her radiotherapy. The latter 2 patients (099, 107) had had widespread radiotherapy which had affected the reticuloendothelial framework necessary for stem cell development, and preliminary cell aspirates in allegedly unirradiated areas did appear hypocellular. Patient 107 appeared to possess normal granulocyte reserves, one of our marrow screening parameters, only because we were given an incorrectly high body weight on which to base our etiocholanolone dosage, thus falsely elevating the marrow granulocyte reserves. From this unfortunate experience we now insist that a candidate for marrow autotransplantation have a normal iliac marrow aspirate histologically, a normal bone marrow scan employing technetium 99m sulfur colloid, and normal granulocyte reserves measured with etiocholanolone (after we weigh the patient) as indicators of normal marrow function. At autopsy, Pa-

TABLE VII

WHOLE BODY IRRADIATION WITH MARROW TRANSPLANTATION

Study No.*	Type of Transplant	Whole Body Dose (rads)	Date of Marrow Removed	Date of R_x	Date of Marrow Reinfused	No. of Cells Reinfused	Viability	Marrow Frozen	Complications of Infusion	Outcome of Autograft
051	Auto	150	4/26/65	5/1/65	5/25/65	1.6×10^9	55%	Yes	†Hemoglobinuria for 1 day	Did not take
053	Auto	200	5/ 4/65	5/ 8/65	5/27/65	1.4×10^9	57%	Yes	†None	Did not take
070	Auto	150	5/ 4/65	3/ 2/67	3/13/67	0.33×10^9	68%	Yes	None	Did not take
077	Auto	200	10/31/67	11/ 7/67	11/ 9/67	0.79×10^9	48%	Yes	Hemoglobinuria for 12 hours	Did not take
078	Auto	200	11/ 4/67	12/ 5/67	12/ 5/67	4.16×10^9	96%	No	None	Possible partial take with platelets never below 125,000/mm.^{3} but leukocytes 900/mm.^{3}
087	Iso	200	3/ 3/69	2/27/69	3/ 3/69	4.38×10^9	99%	No	None	Take
090	Auto	150	2/ 2/69	2/ 2/69	2/ 2/69	15.6×10^9	96%	No	None	Cerebrovascular accident killed patient 6th day after R_x
091	Auto	200	7/ 2/69	7/ 2/69	7/ 2/69	4.6×10^9	98%	No	None	Take
095	Auto	200	11/ 5/69	11/ 5/69	11/ 5/69	3.07×10^9	97%	No	None	Take
098	Auto	200	1/27/70	1/27/70	1/27/70	7.42×10^9	98%	No	Transient hypotension before infusion	Take
099	Auto	230	3/ 3/70	3/ 3/70	3/ 3/70	5.32×10^9	95%	No	None	No take
107	Auto	200	12/15/70	12/15/70	12/15/70	3.2×10^9	95%	No	None	Take doubtful-leukopenia but no sepsis
111	Auto	200	5/19/71	5/19/71	5/19/71	7.4×10^9	96%	No	None	Take

* See footnote to Table 1.
† Unfiltered marrow infused.

TABLE VIII

RESULTS OF SUCCESSFUL ISO- AND AUTOTRANSPLANTS OF MARROW AFTER 200 RADS MIDLINE WHOLE BODY IRRADIATION

Study No.	Day of Leukocyte Nadir	Leukocyte Count at Nadir (cells/mm.^{3})	Nucleated Cell Count Infused Per Kilogram Body Weight‡
087	26	2,100	1.6×10^8
091	25	4,100	2.3×10^8
095	33	2,700	0.6×10^8
098	28	2,200	1.7×10^8
111	31	3,000	1.4×10^8
Mean	28.6	2,820 ± 804†	1.5×10^8
Mean of Controls*	24	850 ± 380†	—

* 7 patients receiving 200 rads whole body radiation without transplantation of marrow.
† The means differ significantly by the t test at $p < 0.001$ and by the Wilcoxon two sample test at $p < 0.02$.
‡ It has been estimated that 1.1×10^7 cells/kg. are required for a successful marrow iso- or autotransplant.[44]

tient 099, who died on Day 31 post irradiation, had widespread carcinoma of the pancreas. Patient 107 survived her pancytopenia without any evidence of sepsis. Patient 111 had no significant cytopenia and her hospitalization (including autotransplant) lasted only 4 days.

This technique has been of advantage in simplifying the patient's course and eliminating the long period of hospitalization needed prior to transfusion. The possibility of reinfusing tumor cells in the untreated marrow exists, but the elimination of this problem awaits the development of successful methods of marrow allotransplantation.

SUMMARY

1. Whole and/or partial body radiation therapy given in single doses has shown beneficial effects in the control of certain advanced cancers. The palliative effects compare favorably with results using anticancer drugs as commonly reported in the medical literature.

Irradiation certainly seems to improve survival in the untreated patient with cancers of colon, lung and breast.

2. The use of autologous marrow reinfusion immediately after radiation therapy minimizes the characteristic marrow depression otherwise observed. The degree of illness following infusion is greatly lessened and hospitalization greatly shortened.

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January 3, 1972

The Honorable Mike Gravel
1251 New Senate Office Building
Washington, D. C.

Dear Senator Gravel:

This letter represents our response to your request of us to inquire into the whole-body radiation therapy project being conducted by Dr. Eugene L. Saenger and his colleagues at the University of Cincinnati. We have made our inquiry and our broad conclusions are as follows.

1. In the normal context of a clinical investigation, the project is validly conceived, stated, executed, controlled and followed up. The appropriate scientific and professional committees of the University of Cincinnati have performed their functions during the course of the project.
2. The process of patient selection based upon clinical considerations conforms with good medical practice.
3. The records, publications and patient followup are voluminous and commendable.
4. The procedure used for obtaining patient consent is valid, thorough and consistent with the recommendations of the National Institutes of Health and with the practice of most cancer centers.
5. Should this project come before the Senate or one of its committees in some fashion, we would urge your support for its continuation.

Though physicians do not invariably share with the public the ways in which they reach professional conclusions, we think it appropriate to your inquiry to detail below the way in which we reached these conclusions. Our acceptance of your request was based upon the realization that senators have need of expert, impartial medical and scientific advice in evaluating complex biomedical problems. Should you desire further information, we will again endeavor to be responsive.

The committee

As I noted in my earlier letter to you, the College is seldom called upon to investigate the scientific efforts of any of its members and thus has no standing committee with such a charge. Instead, I asked two leading radiation therapists and a third distinguished physician to undertake the inquiry. They are:

Dr. Henry Kaplan, chairman and professor of radiology at Stanford University Medical School in Palo Alto, California. Dr. Kaplan is internationally known for his pioneering work in several areas of cancer therapy. He has been a member of various cancer study and advisory groups including the Committee of Consultants to Conquer Cancer which recently advised the Senate. His extensive bibliography includes descriptions of his work on Hodgkin's disease involving extensive radiation of patients. Dr. Kaplan is currently chairman of our Commission on Cancer.

Dr. Frank R. Hendrickson, chairman of the department of radiation therapy at Chicago's Presbyterian-St. Luke's Hospital. Dr. Hendrickson is also a faculty member of the University of Illinois College of Medicine and the Rush Medical College as well as a consultant to the Veterans Administration and a member of various national cancer bodies. His bibliography includes reports of his treatment of children afflicted with Ewing's sarcoma with radiation. He is the present chairman of our Commission on Radiation Therapy.

Dr. Samuel Taylor, III, a distinguished internist and oncologist at Presbyterian-St. Luke's Hospital in Chicago. He is the founder of the American College of Physicians cancer program. He is a professor of medicine at Rush. Dr. Taylor's wide experience as a senior investigator in the field of cancer provided us with a view from another discipline. He is a long time expert in chemotherapy of disseminated cancer.

Mr. Otha Linton, director of our Washington Office, provided staff support to the group and coordinated their inquiry with Dr. Saenger and his colleagues.

Nature of the inquiry

Drs. Kaplan and Hendrickson and Mr. Linton met with Dr. Saenger and Dr. Charles M. Barrett, director of radiation therapy at the University of Cincinnati, November 29 in Chicago. The discussion covered the background of the project and the purposes, objectives and achievements of the effort to date. Dr. Saenger then provided the committee with published papers and summary materials about the project.

On December 16, Drs. Kaplan, Hendrickson and Taylor met in Cincinnati with Dr. Saenger, other members of his team, two members of the University of Cincinnati human investigation committee, and the chairman of the special university committee which was created by the president to review the project.

Those interviewed were, from the UC Human Research Committee, Dr. Evelyn V. Hess, professor of medicine and Dr. Harvey C. Knowles, Jr., professor of medicine, from the special university committee to review the Saenger project, Dr. Raymond R. Suskind, professor of environmental health and medicine, from the department of radiology and the study team, Drs. Charles M. Barrett, Harry Horwitz, Bernard S. Aron and Edward B. Silberstein, physicists, Drs. I-Wen Chen and James G. Keriakes, and the psychologist, Mrs. Carolyn N. Winget.

Dr. Saenger and everyone at the university were willing to recognize our competence and to cooperate fully with our inquiry. The committee members were extended full cooperation and can conclude that they apprised themselves of the situation to the same extent that they would have needed to do as members of an NIH study section or site review team. Each member of the committee has served in such a capacity.

The committee viewed the project as it was designed---as a clinical investigation of a modality for the care of cancer patients with extensive and incurable disease. Phase one investigations follow basic animal work and always precede randomized clinical trials which may or may not be justified on the basis of the first human applications.

In the opinion of the committee, the team at Cincinnati had abundant bases in the literature for undertaking its study. The participants are fully qualified to undertake the investigation, both from the viewpoint of good patient care and importantly the possibility that new and valuable clinical information could be obtained.

Our committee did not concern itself with the implications which have been raised concerning partial funding of the effort by the Department of Defense. We did note that DOD funds were used only to support the laboratory and psychological studies but not the treatment or the care of the patient. The basic costs were borne by the university and its teaching hospitals.

Because of the prevalence of cancer which has been noted so recently by the Senate, the House of Representatives and the President, those charged with the care of cancer patients have need for every possible bit of information concerning the methods and modalities which we use to treat these patients. In our opinion, this project has the possibility of contributing useful clinical information.

It is worth noting that if others have had access only to the reports made to DOD on its part of the project or if they somehow failed to understand that the fact of extensive followup in no way departed or detracted from fundamental precepts of good patient care, then it follows that they might reach conclusions different from those of our committee.

The nature of cancer investigations and treatment

In clinical investigations of cancer, we are concerned both with the basic cancer process and with its manifestations in humans and specifically in the patients who present themselves for care. The treatment of an individual represents a series of choices for his physicians which are based upon diagnostic findings and their best judgement. Since humans respond to the assault of cancer and to attempt to treat it as uniquely as they do to most other things, generalizations here have statistical value but limited application to individuals.

There are many forms of cancer. Each type has in common the loss of intracellular control upon which normal cells depend to regulate their growth. The cancers differ in cellular types and in the site of origin of a primary lesion within the body as well as the bodily pathways through which they may spread. Thus, for example, the problem of defining and treating a solid tumor may differ radically from the approach to a form of leukemia.

Physicians have three fundamental modalities which may be used singly or combined to attempt to cure or control cancers. These are extirpative surgery, high energy radiation and chemicals. Hormones also are used to attempt to alter the course of certain cancers involving the endocrine system.

The choice of treatment must be decided for each patient. The decision is based upon the type of cancer, its location, its size, its degree of spread and upon the age and general health of the patient. Ideally, the therapeutic decision is made in a cancer conference involving physicians from the different disciplines appropriate to the problem at hand. By the nature of the disease, any cancer therapy must be regarded as heroic. The cancer patient must accept lesser probabilities of success and more stringent side effects of treatment than usually befall sufferers from other diseases.

Timing is all important in the treatment of most cancers. A small, early cancer may be removed surgically or destroyed with radiation. But if the cancer has begun to spread beyond its original site and beyond the surgical or radiation field, the destruction of the primary lesion will not suffice to save the patient.

Unfortunately, many patients still are diagnosed as having far advanced cancer which must be judged unlikely to respond to any standard curative effort. These patients may have undergone various treatments without success. Or they may have had a "silent" primary cancer which was diagnosed only after it began to spread through the body.

The physician having the care of a patient with advanced cancer has three practical choices. One is to do nothing, allowing the disease to take its course. Another is to attempt palliation, an effort to retard the tumor growth and/or to ease the pain of the patient. The third is to attempt drastic or radical treatments not commonly accepted as reliable or efficacious for patients having a greater chance of success. The third approach carries the long-shot possibility of direct patient gain. The doctor and patient must agree that something of benefit to others may be learned from the effort.

Thus, the effort to improve cancer treatments has been based upon the first application of new or questionable techniques to those patients having nothing to lose by their failure because there is no known treatment available. Often, the effectiveness of the technique must be measured in time of survival, relief of pain, or from certain body measurements, rather than in terms of overt tumor destruction. Efforts must be made to isolate and measure the specific timing, dosages, procedures and restraints which can be observed to alter the course of the disease. When a form of treatment has been shown to have some measurable beneficial effect on far advanced patients it can be considered for general use.

The nature of cancer investigation requires that more than one therapist must undertake a new modality at each stage of its development before it can be accepted for general usage. If an improvement in some tool or resource becomes available, such as the advent of supervoltage radiation sources then previous studies may be repeated with profit.

Both the high energy radiation and the several chemicals now used in cancer therapy have harmful effects upon patients. So does radical surgery. The choice must be made to refrain from curative efforts when the destruction of the tumor would involve unacceptable side effects of a localized or systemic nature. Thus, efforts to control or relieve side effects are equally significant with those to destroy the tumor.

When radiation is used as the tumoricidal agent, the effort is made to limit its effects by tailoring the dose to the suspect area and by using a series of tolerable exposures to destroy the cancer cells without damaging vital organs and adjacent normal tissues. If a cancer is widespread, then a tumoricidal dose of radiation presents problems which, for the most part, remain unsolved. Lesser amounts of radiation have been used in various ways as part of efforts to retard tumor growth, to relieve pain or to alter the pattern of cancer development.

The literature of radiation therapy offers substantial numbers of citations of efforts to use whole or partial body radiation for the palliation of advanced cancers. The conclusion, broadly, must be that the concept has not been sufficient: productive to recommend generally nor so lacking in effect to be abandoned as an approach.

The Cincinnati project

The actual treatment of patients was begun in 1960 by Dr. Saenger and his colleague: as a clinical assessment of the use of sublethal whole body radiation for the palliation of patients with a variety of disseminated cancers. The premise was that the level of radiation selected would have a retardant effect upon the growth of the tumor cells throughout the body and that the patient, for the most part, could tolerate the side effects of systemic radiation.

The second part of the premise was that patients who were closely followed after their cancer treatments could indicate both the physical and psychological reaction to the therapeutic effort over a period of several weeks. This clinical assessment provided a new dimension to previous studies of the use of whole body radiation.

Beginning in 1964, the group began to use the technique of autologous bone marrow transplants as a means of overcoming the marrow depression otherwise inescapable after whole body radiation. The technique after some modification involves the extraction of 300 to 600 cubic centimeters (about a pint or so) of marrow from the posterior iliac crest just before the radiation exposure. The same day, the marrow is filtered and reinjected into the patient. As a clinical procedure, this has succeeded in averting most of the extended radiation syndrome effects previou: observed in patients in this series and in other whole body studies.

Efforts to minimize late effects, such as the drop in white cells and platelets and the decrease in red blood cells which are classic to radiation syndromes, began in 1965. This method using autologous bone marrow immediately after radiation therapy, became practical early in 1969.

The concept of whole body radiation as a method of treating cancer is not new with the Cincinnati project. There is voluminous literature reporting controlled animal experiments which are highly useful but not indicative of human responses to human tumors. The literature reporting on human exposures dates back to efforts in 1923. A review of reports to 1942 showed more than 270 patients thus treated with fairly little encouragement. Since these patients in all cases had disseminated tumors and the radiation sources available were in the orthovoltage range, the results were not surprising.

The advent of supervoltage generators and particularly cobalt 60 sources prompted additional studies to assess the effect of higher energy radiation and led to a new round of studies. In 1953, V. P. Collins and R. K. Loeffler called the use of 200 roentgens whole body "a useful addition to the management of advanced cancer."

A current bibliography contains some 86 scientific articles on the subject, excluding Dr. Saenger's contributions. Whole body projects have been undertaken in more than 42 U. S. medical centers. At present, efforts are underway using whole or partial body radiation for the control of leukemia, Hodgkin's disease, polycythemia vera, multiple myeloma, and disseminated cancers of the breast, thyroid and prostate. In very small groups, whole body radiation has been used successfully in curative efforts against Ewing's sarcoma, a bone tumor primarily of children.

The Cincinnati study through the end of 1970 involved a total of 106 patients referred from the Tumor Clinic of the Cincinnati General Hospital. These were patients found by biopsy and clinical examination to have disseminated tumors. They "were chosen because they suffered from advanced and widespread neoplastic disease such that cure could not be anticipated," in Dr. Saenger's words.

All of the patients underwent a 7 to 14 day assessment period to reaffirm the diagnosis and to determine whether their disease and their general health would make the radiation attempt feasible. Some 24 patients were rejected and received no radiation on the basis of their clinical assessment. Some of the 82 patients later treated received sham radiation sessions during the assessment period but none actually were exposed until after a decision by the team which determined the treatment could be beneficial.

The patients had a variety of tumors. The largest group was 25 with cancers originating in the colon and rectum. A second group of 14 had tumors of the bronchus. Fifteen women had disseminated breast cancer. There were 25 patients with miscellaneous tumors. Three children had Ewing's sarcoma and were treated for curative effect. One of the 25 patients with miscellaneous tumors had Ewing's sarcoma with metastases too widespread for a curative effort.

Discussions with the patients and members of their families are standard in any cancer therapy situation and were a part of this project from its beginning. Specific patient consent forms have been used since 1965, when this step was recommended by the National Institutes of Health.

Since 1968, patients selected for the study were interviewed on succeeding days by the internist in the project before being asked to sign a consent form for the therapy. When possible and in all cases of children, the interview included one or more members of the family who also consented to the treatment. Except for the three children with Ewing's sarcoma, all were told that their cancers had been defined as incurable and that the treatment would be attempted in an effort to prolong their lives and possibly to retard or shrink the tumors. They were told that the information gained from the study was hoped to be helpful to other patients. In the last few years they were told that the information might have military as well as clinical significance.

The patients were told that there could be some side effects from the radiation exposure and that ~~the team~~ would wish to keep in close touch with them for a period of weeks to study their reactions both to the advances in their disease and to the impact of the radiation. The possible side effects were not described in detail nor emphasized to avoid subjective inducement of the symptoms.

So far as the side effects were concerned, the team reported that 45 percent had no vomiting or nausea after the radiation. Some 24 percent experienced transient vomiting and nausea within three hours and another 17 percent had the same symptoms within 12 hours of exposure. Another 9 percent continued vomiting up to 24 hours. Only five percent had prolonged and severe vomiting and nausea.

It is worth noting that these symptoms are certainly no greater than those experienced by patients treated either by surgery or by any of the systemic drugs now being used clinically on disseminated cancers.

The patients were selected by clinicians at the Cincinnati General Hospital from the population served by that institution solely on the basis of their tumor diagnosis. Since CGH is a institution, none of the patients were private patients. The three children with Ewing's sarcoma were referred by physicians at the affiliat Cinainnati Children's Hospital.

Extensive psychological studies were done on 39 patients. It was possible to establish their IQs. The median on the studied group was 87. The range was from 116 to a low of 63. Some 31 of the treated patients were caucasian and 51 were negro. In both race and IQ the group was representative of the patients served by CGH.

The three children who were treated definitively for Ewing's sarcoma remained alive from one to four years after treatment. From the other 79, for whom only palliati was expected, five others survived as of October of 1971, the longest by more than six years.

The clinical assessment of the effort indicated that (with overlapping percentages) 29 percent felt relief of pain, 30 percent showed a measurable decrease in primary tumor size, 11 percent reported an increase in activity on their own part following treatment and 29 percent reported an increase in "well-being." About 29 percent showed no evidence of improvement or change. Four percent were lost to followup. A group of 10 percent or eight patients died from 20 to 60 days after the whole body exposure.

It is not possible to determine positively that those patients who died within 60 days of the treatment would not have succumbed to their disease within that period, even though the clinical assessment had been that their disease was stable enough to justify their inclusion in the study. However, it was noted from the followup studies that their bone marrow function was subnormal and thus relatable to radiation syndrome.

In terms of survival, the Cincinnati group reported results showing an extension of days over untreated patients in each of the tumor categories. However, results were not markedly superior to the survival results reported by other investigators using various chemicals or other combinations.

The survival figures are clouded by the fact that many of the patients included in the sample had already undergone one or more types of treatment unsuccessfully, often only a short time before their inclusion in the study. Some of the patients the study also received extensive followup treatment, sometimes involving further radiation of the primary tumor area.

Thus, the patients received a therapeutic regimen which was clinically judged most efficacious for their survival and palliation, however much the added efforts blurred the observation of the effects of the single whole body exposure.

In specific terms of survival, Dr. Saenger was able to draw rough comparisons which indicated the benefit of some treatment over none. He found that his results compared to those gained by other investigators using surgical resections, drugs such as 5-fluorouracil and, for the breast cancer patients, estrogens and androgens.

In Dr. Saenger's words, "The relatively small numbers of patients in these groups (his and the ones compared from the literature) preclude any claim to therapeutic superiority. On the other hand, it seems reasonable to continue therapy for these gravely ill individuals since this method of treatment is less elaborate and with no greater risk than many present forms of chemotherapy."

In this conclusion, the ACR committee would concur. The committee would also observe that the protocols, reviews by appropriate institutional authorities, attention to patient interests and responsibilities and reporting are all consisten with accepted good clinical and scientific practice.

Responses to Senator Gravel's questions

Some of the points raised in the questions in your letter of November 10 are covered at least in general above. Some are not. Hence, the questions and specific responses are detailed below.

1. ANIMAL DATA: Don't experimental animal trials as a rule precede human trials in the testing of new medical therapies and drugs? What animal trials using partial or whole-body irradiation to treat cancer were completed before Dr. Saenger began his human experimentation? Did Dr. Saenger begin his special "therapy" before or after Defense Department support?

ANSWER: The literature on radiation biology is substantial with regard to animal trials of whole body radiation for a variety of purposes. One bibliography is appended. Almost always, clinical researchers have had the benefit of animal work to test the toxicity of their materials and to develop general patterns of biological response. However, since inter-species differences never allow the total transfer of animal data to human usage, it is necessary to undertake clinical trials under proper conditions to test any new therapy or agent. It is not necessary for a clinical researcher himself to undertake animal work if he has access to and a good understanding of the literature on the subject. This was the case of Dr. Saenger and his colleagues.

As an example of the application of animal studies to human uses, the use of autologous bone marrow transplants and the basic understanding of the influence of marrow stem cells on mammalian survival after whole body radiation exposure were worked out in animal experiments. The marrow transplants are a most important part of the Cincinnati investigation. The detailed biochemistry not only permits a more complete analysis of the response of these patients but also could point the way to other researchers who are attempting systemic therapy with radiation and with investigative chemicals.

It was a necessary part of the clinical investigation for Dr. Saenger to determine the optimal amount of marrow to extract, the most effective way to handle it and the best timing for its reinjection into the patient. At the beginning of their work, Dr. Saenger and his group extracted the marrow and froze it to retain it for the 18 to 21 days during which blood white and red cell levels are expected to decline. With subsequent patients, they determined that the prompt reinjection of the marrow the same day the radiation was administered averted much of the blood depleting effect of the radiation.

Since Dr. Saenger in this instance applied to the Department of Defense, rather than another funding agency, for the support for the extensive biochemical workups which would provide the "new" element of information from the survey, his preparations preceded the 1960 data at which the actual project was funded by DOD and patient treatment began. As noted, the support for the patient treatment and management was provided by the University of Cincinnati and its hospitals. The DOD funds were applied only to the biochemistry and subsequently the psychological testing which allowed a more complete assessment of the effort.

2. **FOLLOWUP STUDIES:** How does Dr. Saenger follow up his own patients to find out if his "treatment" has been helpful or harmful to them? Does he measure the tumors he hoped to reduce, for instance?

ANSWER: As noted, the followup on these patients is considerably more complete than is possible for most tumor clinics. The followup consisted of clinical observations and diagnostic studies and frequent doctor-patient contacts between both the internists and the radiation therapists on the team with the patients who had been treated. In addition, the team psychologist maintained contact, not only for her tests but also as a further supportive measure.

The data on biochemical responses and upon psychological reactions is valuable but simply too expensive in terms of manpower and laboratory facilities to be possible for every cancer patient, even in the best of cancer centers.

The assessment of results was made by clinical observations of the patient which indicate the elements of well-being and systemic function plus laboratory analyses of blood condition and voiding functions plus x-ray diagnosis to check the size and penetration of solid tumors. In many of the patients, the primary tumor had been excised surgically or treated previously with a prophylactic dose of radiation, leaving management of the metastases as the major clinical concern. It is worth noting that only 4 percent of the 82 patients in the 10-year series were lost to complete followup. A detailed report on these results is cited in the preceding section.

3. **CONTROL GROUPS:** What control groups does Dr. Saenger have, or has he arranged for at our great cancer research institutes, so that he can determine how his special "treatment" is working?

ANSWER: The question of specific control groups and randomized samples does not usually arise until after the completion and evaluation of the type of study currently underway by Dr. Saenger. He advises that planning for a more elaborate phase three study began last June on the basis of assessment of the 10-year results of the present effort.

The literature contains sufficient studies of similar patients and comparable sized samples treated by other methods to allow basic comparisons of tumor regression, post-treatment symptoms and survival times after palliation.

Again, it is worth noting that the extent of preparations and followup on each patient and the number of cancer patients at CGH who are suitable for an aggressive palliation study have combined to limit the size of the group under investigation. A phase three study appears feasible at Cincinnati but will require a substantial commitment of staffing and financing from some source other than patient care funds.

4. **PRIVATE PATIENTS:** Does Dr. Saenger treat any private cancer patients, or offer consultation on private cases? Does he recommend or use his partial or whole-body radiation "therapy" on paying patients? Does he know any doctor who does?

ANSWER: Dr. Saenger and his colleagues are full-time faculty members of the University of Cincinnati College of Medicine and have no private practice in the ordinary sense. Their patient care responsibilities are restricted to patients at the city-operated Cincinnati General Hospital and its affiliated institutions. A very few patients were referred to the group from doctors at the Holmes Hospital, a private practice institution affiliated with the university. However, those patients were not charged for the treatment and medical care involved in their participation in the study.

At this point, Dr. Saenger does not use his treatment on "paying patients" because he has none. He does not recommend his technique to other physicians because the investigation is not yet complete and the results are not indicative of immediate application to clinical situations apart from a research effort. Dr. Saenger would encourage other qualified researchers to duplicate his project or to modify his techniques on the basis that results to date are sufficiently promising to warrant further investigation both by his group and by others.

As noted above, some type of partial or whole body radiation is used in more than 42 different U. S. medical centers. A total list of these is not available, but they do include both public institutions like the University of Cincinnati and private ones where most patients are charged for their care and treatment. Thus, it is likely that instances could be found in which patients did pay for this treatment approach. However, the scientific literature does not ordinarily cite the question of patient payment in reporting on clinical research. The ACR committee was not in a position to make any extended inquiry on this point.

5. TRICKERY: Is there any trickery of the patients involved?

a.) Do the patients really understand the experiment is largely to help the Defense Department prepare for nuclear warfare?

b.) Do you consider the release the patients sign to be sufficient evidence that they understand?

c.) Do the patients understand that the experiment may cause them severe discomfort, such as hours of vomiting?

d.) Do the patients understand that partial or whole-body irradiation may shorten their lives, and if so, by how much?

e.) Do the patients understand whether or not there exists any basis for suggesting that the "treatment" may reduce the size of their tumors or reduce their pain (as Dr. Saenger suggests in the Washington Post, Oct. 8, 1971)?

The question of informed consent was investigated extensively by the ACR committee. The University of Cincinnati Committee for Human Investigation was formed in 1965, as it was in most other institutions, and has had a parallel development under the guidelines of the National Institutes of Health. Their consent forms have been gradually modified over the years and the sophistication of their review has increased in a parallel fashion.

It is the opinion of the ACR committee that at the present time and through the years the UC committee has functioned effectively and comparably to similar committees at any of the other leading institutions which conduct cancer research. It is likely that the UC committee has performed its function better than the average group because of the volume of projects generated by the medical faculty and the professional competence of the people involved.

The current consent seeking procedure was reviewed by the ACR committee. The team internist (Dr. Silberstein) interviews patients two times at least 24 hours apart and discusses in extensive detail the procedures that will be undertaken. This is done not only for the patient but also for members of his family, when available. The specific and detailed consent forms are not presented to the patient until the completion of the second interview. The form in use is modified for specificity from the basic ones prepared by the National Institutes of Health.

Except in the case of the three children with Ewing's sarcoma who were treated curatively, the patients knew before being referred to the study team that they had malignant disease for which no curative treatment is possible. They knew that the efforts of the study team were not offered as curative.

Many patients expressed a desire to participate in the study and possibly to help the plight of other cancer patients in the future. The documented psychologic studies which were incorporated in the project beginning in 1965 give the study group more than the usual assurance that their explanations and the required forms were understood by the patients and by their families.

The ACR committee felt that the patients were adequately informed about the nature of the proposed therapy and about the consequences. As noted above, the patients were not informed in detail about the side effects of radiation because of the psychological influence of expectation involved in both nausea and vomiting. As mentioned in the project narrative, about half of the patients did not experience unpleasant side effects and most of the others had only transient symptoms. It should also be noted that since most of the patients had undergone previous cancer treatments, often involving radiation or systemic chemicals, they were aware from previous experience of the types of sequellae which might be encountered.

The patients were advised that the project was designed in the hope that the radiation would relieve the pain of their cancer, that it might shrink the size of the primary tumor or retard the development of metastases. No guarantees of any of those results were offered.

In the ACR committee's view, the assertion in question 5 a. that the experiment "is largely to help the Defense Department prepare for nuclear warfare" is not correct. This is not the primary purpose of the effort and to have advised the patients to that effect would have been misleading.

The patients were not specifically informed that the partial support came from DOD any more than other patients in other studies at Cincinnati or elsewhere are advised of the specific agency support of projects in which they are involved. The Cincinnati patients were told that support came in part from a national agency.

At the time the patients were counseled prior to the request for execution of the informed consent form, they were advised that the possible findings may have more than clinical implications and could be helpful to persons receiving whole body radiation in industrial accidents, military activities or as fallout from a nuclear detonation.

The question of the source of support for a project is not construed by the ACR committee or by most medical investigators as being relevant to the issue of informed consent. In this case, the DOD exercised no control over patient selection or clinical treatment and indeed did not require descriptions of that part of the project been directed primarily toward the assessment of whole body effects of radiation rather than the management of disseminated cancer by radiation, the study group could not have incorporated the autologous marrow transplants which so drastically altered the classic radiation response.

Though this letter has extended to substantial length, it obviously represents a summary of the facts of the Cincinnati study and a precis of the opinions of the College's committee members on that study and on the basic issues of cancer investigation in humans. As we indicated at the beginning of the letter, we would be happy to attempt further discussion of any point on which you may still have concern.

Sincerely,

Robert W. McConnell, M. D.
President
American College of Radiology

Title: Total Body and Large Field Irradiation: Indications and Complications

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Beginning with a suggestion by Dessauer in 1905 and continuing in a wavelike fashion since then, the use of single and fractionated total (TBR) and partial body irradiation (PBR) for various malignancies has alternately attracted and disenchanted radiation therapists. Of particular interest is the fact that since 1970 there have been fifteen reports of external beam treatment in the world literature, eleven of which have appeared between 1975 and mid-1977. This pattern would suggest an acceleration of interest in the use of these modalities.

This presentation will review a work carried out at the University of Cincinnati College of Medicine between 1960 and 1971. The purpose of utilizing TBR and PBR therapy was to ameliorate the course of solid metastatic neoplasms and in a few cases to deliver prophylactic whole body radiation. These techniques were compared in Phase I and Phase II therapeutic trials to the then current methods of chemotherapy. Criteria for patient selection are as follows:

1. There is a reasonable chance of therapeutic benefit.
2. The likelihood of damage to the patient is no greater than that encountered from comparable therapy of another type.
3. The facilities for support of the patient and complications of treatment offer all possible medical service for successful maintenance of the patient's well being.

The details of the total (TBR) and partial body radiation (PBR) techniques are given in reference 14 which gives more detailed description of the project. Therapy was given at 286 cm distance to the midline of the patient with a Cobalt 60 source using two lateral portals for TBR and using the tip of the xiphoid as the dividing point for PBR. Dose rates varied between 3 and 6 r/min at the mid point. TBR absorbed midline doses ranged from 50-200 rad and from 150-300 rad for PBR. The hypothesis that larger single doses could be tolerated well by PBR as compared to TBR was confirmed as discussed more fully below. In almost all of the 89 patients studied radiation was given in a single seance.

In addition to the long term effects of these treatment modalities on the neoplasm itself, extensive studies were done in regard to symptoms, signs and the results of a battery of laboratory tests both before and within a period of a few weeks after the irradiation was given. Also the effect of removal of autologous bone marrow and its reinfusion was studied. Findings from these investigations as they bear on the topic of this symposium will be presented.

All patients gave informed consent following explanation of the investigative nature of the project and formal informed consent forms antedated the requirements of the National Institutes of Health United States Department of Health, Education and Welfare by 2 years.

Selection of patients was limited to those with advanced cancer in whom a cure could not be anticipated as agreed by several physicians and in whom conventional chemotherapy had been shown to be ineffective. All diagnoses were confirmed by biopsy. Patients with leukemia and lymphoma were excluded from this study. All patients were observed for 7-14 days to be as certain as possible that the general condition of the patient was relatively stable since in most instances the patients had serious illnesses of long standing and had usually received considerable previous treatment. In addition during this period certain clinical and laboratory observations and tests were carried out to serve as a baseline. After the treatment these clinical observations and laboratory tests were repeated until marrow recovery had taken place.

RESULTS

1. Effects on Survival and Indications for Use of TBR and PBR

Of 112 patients entered in the study, 85 received palliative treatment and 3 received prophylactic treatment between 1961 through August 1971. These latter 3 cases are not discussed in this paper. It was possible to analyze the effects of the treatment on survival to some extent in three groups of patients and these will be reviewed briefly.

Twenty nine patients with cancer of the colon and rectum comprise the largest group in our study. Their survival was compared with several published reports of patients with colon cancer metastatic to the liver. Our patients, of whom 22 had liver metastases prior to therapy, had a median survival time of 327 days (10.5 months). A group of 61 patients treated by 5 fluorouracil (5 FU) had a median survival time of 255 days (13). A group of 177 patients with liver metastases with no treatment had a median survival time of 146 days (9) and 353 similar patients without therapy had a median survival of 9 months. A series of 419 patients with metastatic liver disease were treated with intrahepatic 5 FU intra-arterial infusion as reported by Ansfield et al (1). In the group reported as improved (55%), the mean survival was 11.6 months, median 7.3. In the unimproved group (45%) the mean survival was 5.6 months and the median 2.3 months (Table 1). Life table analysis showed that the treatment given to our patients was approximately equivalent to that of the patients treated with 5 FU. There was no evidence of life shortening by TBR or PBR. It should be noted that 5 of our patients received 5 FU subsequently and 2 of this group survive in September 1977, 6 and 7 years after treatment.

There were 15 patients with cancer of the bronchus treated with TBR or PBR and their median survival time from diagnosis was 193 days. In a somewhat earlier study from our institution Horwitz et al (7) reported on a randomized trial of alkylating therapy in bronchogenic carcinoma. Typical of the results in this study were the findings that the median survival time with a placebo in 12 patients was 153 days and with chlorambucil was 223 days. The chlorambucil therapy followed localized radiation therapy with ^{60}Cobalt teletherapy delivering a tumor dose of 5000 r in 4 to 5 weeks.

For cancer of the breast there were 15 patients with a median survival from diagnosis to death of 479 days and after treatment to death of 446 days. When compared to patients receiving estrogens and androgens survival was slightly better but not quite as good as patients with breast cancer treated with 5 FU alone.

In regard to palliation some relief of pain, decrease in tumor size, increase in activity or well being was achieved in 56% (48 patients) of patients (Table 2). In 31% (26 patients) there was no change for better or worse. There were 9 cases (10.6%) who died between 20 and 60 days in whom death could possibly be attributed to radiation.

In view of the several recent papers discussing TBR or PBR these results are of interest. Excluding lymphoma and leukemia, various combinations of TBR, PBR and dosage schedules are being employed for such neoplasms as disseminated cancer and Ewing's sarcoma (4), histiocytosis X (6), disseminated neuroblastoma (5), disseminated tumors of adults (8). In this latter paper published in 1977, the authors find that TBR using 8 Mev x-rays in doses of 125 rad given three times at 2 week intervals was comparable even in solid tumors to the results of chemotherapy in certain cases of generalized cancer. In a review of fractionated total body irradiation (2) the Committee for Radiation Oncology Studies cites the work of Loeffler and Puterbaugh (11) using subtotal body irradiation for metastatic breast and prostate disease. In a detailed discussion of adjuvant radiotherapy trials in breast cancer Stjernsward (15) suggests TBR or PBR as a possibility for systemic therapy. He suggests that this method be explored in high risk operable Stage II tumors and in palliation for Stage IV neoplasms. This author and the previously cited Committee report stress the need for appropriately designed studies of the modalities and dosage schedules.

2. Contraindications

Prior to initiating TBR or PBR it is essential to evaluate the patient for 1-2 weeks to ascertain whether or not the patient's condition is sufficiently stable so that the treatment can be tolerated. A total of 112 patients were initially entered in our study. During this evaluation period 24 patients (21%) were not continued in the study either because the treatment was considered too risky or another form of treatment was considered preferable. In some patients, the progress of the disease was considered too rapid. Recently Prato et al (12) report an increased incidence of radiation pneumonitis after single doses of PBR to the upper body of 800 rad when additional localized radiation therapy precedes or follows or in the presence of concurrent lung disease.

Thus in regard to the clinical usefulness of TBR and PBR we are perhaps about to embark on a new period of evaluating these methods in the prophylaxis and therapy of various stages of cancers of organs other than lymphoma and leukemia. One may suspect that these interests are spurred to some degree by disillusionment with chemotherapy. Also a clearer understanding of radiobiology of tumor cells suggests that a single dose of 300 rad has a cell lethality of 90% but at 800 rad it is 99.5% (4).

3. Clinical Observations Useful in Management

Initially we had postulated that patients who had received high doses of localized radiation therapy to one or several portals would be more susceptible to the prodromata of the acute radiation syndrome (ARS) than would patients with metastatic disease who for whatever reasons had neither irradiation or systemic chemotherapy. To our surprise this hypothesis was not confirmed. Patients withstood TBR and PRB irrespective of the extent of previous disease providing they were not too debilitated by the tumor itself.

A second point of interest concerns the frequency of nausea and vomiting in 88 cancer patients receiving up to 200 rad of TBR and 300 rad of PBR. In 44% no nausea or vomiting was noted. In an additional 41% there was nausea and vomiting within 6 hours. In only 15% did these symptoms persist for 12 to 48 hours (Table 3). Nausea and vomiting occurred independently in respect to TBR or PBR although the hematological response for equal absorbed doses was quite different. In the case of a patient receiving 200 rad of TBR the typical depression of white blood count and platelets occur with a nadir at 25-30 days. With PBR up to 300 rad there is slight depression of the formed elements of blood.

Kereiakes et al (10) developed a model for non-uniform exposure expressed in terms of uniform whole body irradiation that results in an equal cell mortality rate. Thus these whole body exposures can be considered as being "dose equivalent" rather than absorbed dose.

One of the most useful therapeutic measures developed in our study was the use of autologous marrow to ameliorate the clinical and hematological effects especially of TBR in high doses. We had hypothesized that if one stored marrow from the patient and then reinfused the same marrow, it should serve to repopulate the marrow. Our first efforts failed because we tried to store the marrow for 2-3 weeks and then reinfuse it. Marrow viability in these instances was about 55%. With some technical improvements viability has now been increased to 90%. Eventually we obtained up to 500 ml of marrow on the day of treatment and reinfused the marrow through a special triple filter system immediately after treatment. In 5 patients so treated the nadir of the mean WBC was 2020 ± 804 cells per mm^3 whereas in the 7 patients without an autograft the level at the nadir was 850 ± 380 cells per mm^3.

Most significant is the fact that hospitalization of these patients was decreased to less than 5 days and that there was no infection or hemorrhage.

In two patients with hypocellular marrow the autografts were not successful. It is now thought necessary that each patient have a normal iliac marrow histologically, a normal bone marrow scan with ^{99m}Tc sulfur colloid and normal bone marrow reserves as measured with etiocholanolone.

The technique of marrow transfusion has of course the possibility of reinfusing tumor cells which were not irradiated although multiple histological sections are screened for metastases before infusion. The reinfusion technique shortens the pre-treatment observation period, decreases the prodromata and minimizes post-therapy hospitalization. The further exploration of this technique should permit the use of higher doses of TBR and PBR with concomitant simplification of patient management. Reports of improved techniques have recently been published (3, 16).

The relative simplicity of these methods of therapy and the lesser cost to the patient stresses the importance of adequate properly designed clinical trials. Such trials should explore comparisons of distribution and dose schedules and comparisons with chemotherapeutic regimens. The possibility of combined TBR and chemotherapy should also be evaluated.

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Table 1

The Clinical Results and Survival Times of the Improved and Unimproved Patients with Intrahepatic 5-FU Arterial Infusion*

Total number of patients	419
Number of study patients	293
Number improved	161 (55%)
Survival (months)-mean, 11.6; median, 7.3	
Still living 16-66 months	13
Number unimproved	132 (45%)
Survival (months)-mean, 5.6; median, 2.3	
Still living 14-72 months	8

Table II

Incidence of Nausea and Vomiting in 88 Cancer Patients Receiving Whole and/or Partial Body Radiation Therapy

	Patients	Per Cent
No nausea or vomiting	39	44
Nausea and/or vomiting up to 3 hours after R_x	23	27
Nausea and/or vomiting up to 6 hours after R_x	12	14
Nausea and/or vomiting up to 12 hours after R_x	3	3
Nausea and/or vomiting up to 24 hours after R_x	7	8
Nausea and/or vomiting up to 48 hours after R_x	0	-
Nausea and/or vomiting 48 hours +	4	4
	88	100

Table III

Palliative Effects* of Treatment
(85 Patients+)

	Per Cent
Relief of pain	31
Decrease in tumor size	31
Increase in activity	13
Increase in well being (weight gain, appetite improvement, subjective statement by patient)	30
One or more of the above	56
No change	31
Lost to follow-up for evaluation of palliation	4
Death between 20 and 60 days possibly attributable to radiation	9

*In some of the patients there was more than one indication of improvement; thus, the percentages exceed 100 per cent.

+3 children with Ewing's tumor received prophylactic treatment and are not included in this analysis.

Mr. **Walgren.** My question to you and the agency—and I won't shock the audience with the contents of that study, but my question, then, to you and the agency, who are your supervisors, after having read that part of the transcript, is to ask whether you are the proper one to be in charge of this study and whether the public should or will believe, beyond any doubt, as they have a right to believe beyond any doubt, the results of that study after you are done with it.

Mr. **Carter.** Mr. Chairman, there is also a rather interesting part of that, concerning the patients who received Saenger's treatment. According to the chapter I've reviewed, all but three were charity patients from Cincinnati General Hospital and none could pay for the medical treatment. They had an average schooling of 6 years, with an IQ of 86. Normal is 100. Many were elderly; few had immediately relatives. About 60 percent were black.

Saenger and his team claim that these patients were given a full explanation of the risk before they signed for treatment. How many of those with an IQ of 86 would have known? It is disturbing to me to read these things. It is somewhat like a nightmare, to read this—to do human experimentation on poor black people. If such treatment is necessary, and I don't feel that it is, Mr. Chairman, it seems to be going to extreme lengths to accomplish to find a cure for cancer.

There was one other thing that I wanted to respond to and that was from Mrs. Tompkins. There was a paper concerning a study of Mrs. Tompkins', I believe, to the effect that Saenger overlooked the fact that even at low doses, an average of about 113 rad to bone marrow compared to 15 rad per year permitted for occupational work, there was a significant increase in leukemia among persons of age 50 to 79 due to iodine-131.

This also indicates Tompkins had employed a statistical method that lacked the power to detect even large differences between the two groups, those with and those without iodine-131.

Thank you, Mr. Chairman.

Mrs. **Tompkins.** What are you quoting from?

Mr. **Walgren.** Going back to Dr. Tompkins, do I understand, Dr. Tompkins, you believe that there are certain levels of radiation that might be beneficial?

Mrs. **Tompkins.** Well, certainly in the treatment of cancer, I believe there are.

Mr. **Walgren.** How about for the nonsick person?

Mrs. **Tompkins.** I would certainly never recommend exposure of a nonsick person to radiation for any reason.

Dr. **Lushbaugh.** How about medical checkups?

Mr. **Walgren.** That is not my thrust. My thrust is the radiation, itself, not the product of the radiation. Just the concept. Have you ever believed that low-level radiation might, in any sense, been helpful to the natural human being?

Mrs. **Tompkins.** There have been suggestions—since I was asked this during the break, I assume this is what you are referring to—there have been suggestions in animal studies that exposures to low levels of a toxin, including radiation as one of the toxins, that is anything that insults the body, can increase the repair mechanism and in the process can repair things other than the damage done by the low-level insult. If the level of the repair mechanism is overwhelmed, of course, all bets are off.

Now whether this applies in humans, I don't know. We are certainly not going to know because we would have to experiment to find out. There are suggestions of this in animal studies.

Mr. **Walgren.** Could we just cite those studies for the record?

Mrs. **Tompkins.** I am sorry, I have not thought about this for over 5 years. I am being asked about something which I was overheard to say in a social conversation in 1972. I would have to look up these references.

Mr. **Walgren.** I think it would be worthwhile, and we will hold the record at this point for any support that you would like to give to that point so that the record reads and that point can be documented.

[The information asked for was not available to the subcommittee at the time of printing.]

Mr. **Walgren.** Going to the study that you were involved in concerning X-ray and iodine-131 exposure——

Mrs. **Tompkins.** Not X-ray, sir. It was just iodine-131.

Mr. **Walgren.** Is it true that you made the decision to terminate that study?

Mrs. **Tompkins.** The decision was made by my immediate superior. The study had already cost $8 million. Negative studies don't gain budgets. It was decided that we could not afford to continue the study at the minimum cost of $400,000 a year, which at that point was practically our total budget, when there was no evidence that continuing it would change the results in the foreseeable future.

What we did was guarentee that all of the records for all of the patients would be available at each of the study centers so that it would be possible to go back and reopen the study at some subsequent date.

My understanding is that that is now in the process of being done.

Mr. **Walgren.** Was there dispute between you and others involved in that study as to whether or not that study should be terminated?

Mrs. **Tompkins.** There were several study directors who were extremely unhappy to have their contract for the collection of the data canceled.

Mr. **Walgren.** You feel it was, then, a financial resistance on their part?

Mrs. **Tompkins.** In part. One study director was concerned about the length of the followup, but it had nothing to do with leukemia. His concern was thyroid cancer. The problem, as I tried to explain to him, was that the study was not designed to answer the question of thyroid cancer. We did not have an adequate control group. If the patient had had his thyroid gland removed surgically, it could not go on and develop a malignancy. So we had no control group. Continuing the study for the purpose of studying thyroid cancer, I felt, would be misspending the taxpayers money.

Mr. **Walgren.** Inasmuch as the public is going to be investing their confidence in your views on this matter, and I don't mean to suggest that you are not totally independent, but your husband is involved in nuclear research?

Mrs. TOMPKINS. No, sir, he has retired.

Mr. WALGREN. Can you tell me a little bit about what he did in the nuclear area when he was active?

Dr. LUSHBAUGH. He is in the room. Would you like to talk to him?

Mrs. TOMPKINS. He is in the room. Would you like to ask him, sir?

Mr. WALGREN. Maybe we can get some yes or no answers, so that we can see who is doing what in this area.

Mrs. TOMPKINS. He joined the Manhattan District in 1944, and we moved to Chicago. In 1946, we moved to Oak Ridge, where he was at the Oak Ridge National Laboratory. In 1950, we moved to San Francisco, where he was with the Naval Radiological Defense Laboratory.

Mr. WALGREN. What did he do in that capacity?

Mrs. TOMPKINS. He was scientific director of that laboratory after about 2 years.

Mr. WALGREN. What was the major work of that laboratory?

Mrs. TOMPKINS. To determine how to—that was a large program——

Mr. WALGREN. Is it true they were involved in supervising the naval nuclear bomb testing program in the South Pacific?

Mrs. TOMPKINS. I don't believe so. They were involved in them certainly; how to decontaminate ships, how to protect the personnel. It was all pretty classified, sir. I wasn't there and I wasn't cleared.

Mr. WALGREN. But your husband was the scientific director of the Navy's Radiological Defense Laboratory at that time?

Mrs. TOMPKINS. That is correct.

Mr. WALGREN. At a time when the Navy was carrying out its nuclear bomb testing program. Your husband also served as a consultant to the Sandia Corp., which was involved in the building of atomic bombs for the military; is that true?

Mrs. TOMPKINS. I really don't know.

Mr. WALGREN. You do not know. You never saw a check from the Sandia Corp. for consulting fees?

Mrs. TOMPKINS. He has been in the Government service since we went to San Francisco.

Mr. WALGREN. Then your husband became the Chief of the Research Branch of the U.S. Public Health Services Radiation Health Division.

Mrs. TOMPKINS. That is right.

Mr. WALGREN. After that he joined the U.S. Atomic Energy Commission as Deputy Director of the Office of Radiation Standards?

Mrs. TOMPKINS. Yes.

Mr. WALGREN. I understand that during that involvement, the levels of iodine-131 in the environment, the standards for those levels, were substantially increased.

Mr. TOMPKINS. I would like to talk to that point, sir.

Mr. WALGREN. Will you come forward and give the committee your name

STATEMENT OF PAUL TOMPKINS

Mr. **Tompkins**. My name is Paul Tompkins. I was formerly the Executive Director of the Federal Radiation Council, which was an interagency committee charged with the responsibility of recommending to the President radiation standards directly or indirectly affecting public health.

The big interest in iodine-131 was developed mostly from the work of the Bureau of Radiological Health, and reached its major public attention at the time immediately following the early moratorium on atmospheric testing set up and approved by President Eisenhower.

In late 1959, the U.S.S.R. initiated a new series of atmospheric tests, during which time the significance and prevalence of radioactive iodine resulting from those tests were well documented. Wherein I stated that the standards regarding releases to the environment were not changed, rested on the interpretation of FRC Report No. 2 that gave limits of iodine which were not to exceed 100 picocuries per day. The question of how these report No. 2 recommendations should be interpreted were a point of interagency controversy at that time. I took the position that those recommendations were intended to apply to what the FRC calls normal peacetime operations, which we interpret today as being installations such as nuclear powerplants.

Now the critical element there is that the quantities released are capable of close control. In the internal Government controversies that occurred at that time, I took the position that from the language of the report, it could apply to fallout, but technically and administratively, it made no sense to do so, the reason being that most of the iodine we were coping with at that time was not of U.S. origin; they were Russian in origin. There was not one thing we could do to limit the source.

Then the question came up, OK, on balance, when does radiation or radioactive material in the environment justify initiating public health countermeasures?

It was the consensus of all of us who were involved at that time that those standards should be considerably higher than those intended to limit deliberate release. We did come out with a recommendation that was couched in the terms of a protective action. The number was indeed 20 times higher than the 100 picocuries per day or, if you wish, the 1½ rad per year that was the limit for the thyroid dose.

We incorporated in that another stipulation that the new guide was a dose which, if projection indicated it would be received, protective action should be initiated to prevent it.

And that was a totally different conceptual public health management problem than the normal release standards. Those things, we did do.

I think it should be understood it was the view of a totally different problem than the original standards in report No. 2.

That is all I have to say, sir. Thank you.

Mr. **Walgren**. Thank you.

Mr. **Carter**. You increased the standard 20 times; is that correct?

Mr. TOMPKINS. No. We said that a projected dose 20 times the annual allowed dose was high enough so that steps should be taken to prevent its occurring. That is not a change of standard. That is an entirely new standard.

I would like to make this point. The U.S. approach——

Mr. CARTER. Go ahead.

Mr. TOMPKINS. The approach we finally wound up taking in the Federal Radiation Council was a little different than the ones our colleagues in Great Britain took at the time of the accidental release of iodine at Windscale. There they adopted a concept very similar to the limit proposed for limiting exposure under controlled conditions. They adopted the value of 25 rad to the thyroid which they would permit and then dumped all milk that would have a higher iodine content which would cause a higher dose.

The other part of their philosophy, which was never stated in public but was described to me by a member of their committee, was that they were perfectly willing to dilute high-level milk with low-level milk in order to maintain that 25-rad limit to the thyroid.

The concept that was taken by the working group of the FRC was simply that dilution was no solution. If you are going to eliminate it, eliminate it. So, we didn't adopt a maximum permissible dose limit.

Mr. CARTER. You did not adopt the maximum permissible dose limit?

Mr. TOMPKINS. We did not.

Mr. CARTER. Did you set any acceptable level?

Mr. TOMPKINS. No. We set an unacceptable level, which was about 30 rads.

Mr. CARTER. About?

Mr. TOMPKINS. Thirty.

Mr. CARTER. That is to the thyroid?

Mr. TOMPKINS. Yes, sir.

Mr. CARTER. I might have been misinformed. It is my understanding that you had increased the permissible range of radiation by a factor of 20.

Mr. TOMPKINS. There are several people who have made that statement, and they are wrong, which is the reason I thought I should explain our position to you myself. We did not raise the acceptable level. We did establish a level which we considered unacceptable.

Mr. CARTER. You established a level which you considered unacceptable?

Mr. TOMPKINS. Unacceptable.

Mr. CARTER. Thank you, Mr. Chairman.

Mr. WALGREN. Thank you, Mr. Carter.

Thank you, Dr. Tompkins.

I just feel that, as one opinion of the views that have been expressed to the committee, that asking the people that the Department has sent and put in charge of this study, who have been involved in the study of exposures under atomic testing, both in the Army and in the Department of Energy, asking these people to take a skeptical approach to the damage from low-level radiation or to be skeptical about how safe low-level radiation might be is really like asking a telephone pole lineman to think of telephone poles as ugly; and of course, he just won't do it.

I would question very strongly whether the public would have confidence in the result of a study conducted by the personnel that had been offered by the Department of Energy, and I believe that the public has a real right to a skeptical approach to the safety of low-level radiation, and I have not seen that.

We appreciate your coming before the committee.

Mr. **CARTER**. Mr. Chairman.

Mr. **WALGREN**. Yes.

Mr. **CARTER**. I have one other thing, if you don't mind.

I don't disagree with the gentleman; maybe he was maligned. He appears to be a very nice man.

Mrs. **TOMPKINS**. I like him.

Mr. **CARTER**. Well, I can understand that. I am sure he is a nice man.

Maybe we have the wrong material, but during Mr. Tompkins' tenure, the levels of iodine-131 in the environment from fallout reached the highest peak ever recorded. Of course I believe, as you state—and I will accept the fact—that we were not the cause of that. That came from Russia. Is that what you said?

Mr. **TOMPKINS**. Yes, sir.

Mr. **CARTER**. But when Mr. Tompkins became Director of the Federal Radiation Council, from 1964 to 1965, the Council increased by 20 times the amount of radioactivity that would be permitted in the environment in the event of a leak from an underground test or accidental release from a nuclear reactor. Is that misinformation?

Mrs. **TOMPKINS**. I think the staff had better go back to original documents for information.

Mr. **CARTER**. I will let Mr. Tompkins speak, if he wants to. Is that misinformation?

Mr. **TOMPKINS**. Worded exactly as you have, yes, sir.

Mr. **CARTER**. Worded differently, how would it be?

Mr. **TOMPKINS**. The way I just described. Our philosophy is that the human body can't tell the difference between radiation coming from natural background, from iodine either from Russia or iodine from a reactor or iodine from anywhere else.

Consequently, when you talk about public health actions from iodine in the environment, it does not matter where it came from.

Mr. **CARTER**. Thank you, Mr. Tompkins.

Mr. **WALGREN**. We appreciate your coming before the committee. I am sure the committee will be in touch with you. Please feel free to do the same, because we do feel that we benefit from your information. We want to try to have the right outcome in the execution of public trust. Thank you very much.

The next witness is Dr. Allen Brodsky, Senior Health Physicist, Occupational Health Standards Branch, the Office of Standards Development, U.S. Nuclear Regulatory Commission.

We welcome you to the committee. We have your written testimony. That will be made a part of the record. You can proceed as you desire.

STATEMENT OF ALLEN BRODSKY, Sc. D.

Dr. **Brodsky.** I hope I don't put my feet in my mouth.

First, I would like to extend my appreciation to the committee for allowing me to appear here, and my appreciation of the committee's diligence in trying to get the facts and all the views in what is such a very complex area, as we can see.

As I sit here, I think I had better make a few preliminary remarks about my testimony to make it clear whom I am representing and what I am representing.

First of all, as I state in my preface—to my prepared remarks below—I am here representing myself alone. My agency did not approve nor disapprove of this. They have not tried to influence what I am saying. They have been very good about that. So, I am on annual leave today and I am here at my own expense.

Mr. **Walgren.** I might just interrupt. That is at least remarkable, isn't it, that the agency has not tried to influence you in one way or another.

Dr. **Brodsky.** I don't think it is remarkable. Maybe sometimes with some people it might be. There are all kinds of people in an agency as there are in the world. We can talk about this later.

Mr. **Walgren.** Sometimes it occurs and sometimes it doesn't occur.

Dr. **Brodsky.** Basically, I have been treated very well, I am very happy with my job.

Second, I have submitted for the record not ~~all of~~ the references that I have referenced in my statement, since some of them are published. I believe Mr. Rogers held up a yellow report, which was the first formal publication of the Mancuso-Sanders-Brodsky study. I see you have copies of that. I know that you have copies that were distributed of the Mancuso-Stewart-Kneale paper, which is the main subject of my discussion today. I have a different view of the paper.

I felt, as a citizen, I should offer that view to you, for whatever it is worth. I feel since I am speaking here as an individual and not as a representative of the Nuclear Regulatory Commission, I probable should provide a few details about my background. You have my short résumé and my long résumé, and you can decide what to do with them for the record. I was notified only a few days ago that I was testifying. I suppose you may not have had a chance to review my résumé, so I thought you would want to know who is talking and why.

First of all, my career started out in 1949. I was one of Dr. Karl Morgan's first students in the health physics fellowship program, the second year of the program under Dr. Elda Anderson. I want to make it clear that ever since I was taught by Dr. Morgan and Dr. Anderson, I have faithfully, I feel, pursued the philosophy that any rediation exposure that was not necessary, and more than balanced by another effect that might save a life or save health, was not justified. I have also followed in my career the principle that Dr. Morgan taught me and that is to minimize radiation exposure as far as one can below the limits. I think we have done a lot of this. Not too much has been said about this. I can provide a lot of documentation about things I have done in that direction.

Second of all, since I was in the career of radiation protection as a health physicist from 1950, when I received my first job in the Naval Research Lab as the head of health physics, until 1961, when I decided to leave the Government and get another view, I had many experiences that showed me: We knew a lot about how to reduce radiation exposure; we had some idea regarding the upper limits of the probable effects, but I didn't feel, having degrees only in chemical engineering and physics and one year of training in health physics with some biology, that I yet had an adequate background to understand these important types of epidemiologic studies we are talking about, which are part of the basis of our radiation protection standards.

I had a lot of curiosity about them. I wanted to read some of these papers myself and make up my own mind. I also wanted to do my own studies on the accuracy of exposure records because there was controversy about that, as you remember.

So I took the opportunity to leave the Government at the point where we had finished writing certain regulations, and so on, to go back and study biostatistics and radiation health. As has been indicated today, biostatistics is a field where you learn how to evaluate health studies of human populations, as well as animal experiments at the laboratory level: You also learn the purposes of statistical methodology.

I was fortunate enough to be able to work with Dr. Niel Wald at the University of Pittsburgh on a pilot epidemiological study. I had never before carried out an epidemiological study, but with Dr. Wald I had an opportunity to do some research about the radiation measurement data that would be used in a radiation epidemiologic study—the kinds of data that I later helped collect for use in the AEC health and mortality study directed by Dr. Mancuso.

Because of this experience, I think Dr. Mancuso came to me to attend the first meeting at the University of Pittsburgh with the people of the Division of Biology and Medicine, USAEC, who wanted to approach the University of Pittsburgh to do an independent study to define whether there were any discernible effects on atomic energy workers exposed to radiation.

I think you know from the record I was a coinvestigator with Dr. Mancuso and Dr. Sanders for 8 years. We wrote the proposals together and attended meetings together. Dr. Mancuso was wonderful to me. He treated me as a member of the team. I have good things to say about Dr. Mancuso.

Second of all, part of my research as a doctoral student happened to be a model of carcinogenesis. It is a limited model. I did not have time to check it very much. But what I would like to say—and it is in the record, this paper is now in publication in Health Physics—I have shown there is a relationship between radiation dose and risk of cancer that does fit some data on radiation carcinogenesis. Mainly I want to point out the fact that I do believe radiation can cause cancer with a certain probability that depends on dose and rate of application. If anyone doubts that, all they have to do is look at my published paper when it comes out. It shows I have positive coefficients in my theory relating cancer to radiation at all levels of dose, so I am not sweeping anything under the rug. I do believe that radiation can cause cancer, but the questions we are here to discuss are: What is the probability, at each dose and dose rate; and under what conditions? These are the difficult questions that must be answered as accurately as possible.

I don't think our country can provide the best legislation on the basis of fallacy. We need facts. If we can't get facts, we ought to try to bracket the facts. We ought to try to know what those probabilities are, because they have to be balanced against the beneficial uses of radiation, some of which have been mentioned.

I think all of us together can iron this out eventually.

Mr. WALGREN. That is one of the things that bothers me. We are all here together. It makes me wonder where the other side of the question is.

Mr. BRODSKY. There are many sides to this question. As a matter of fact, I don't think I really can begin to give to you all of my side of the question in the short time here, but I would like to at least introduce what I am thinking about.

One more thing I would like to make clear at the beginning. I said this to Dr. Mancuso last May. When I visited him he was not happy with me. I have said it to other people. I can probably find witnesses I said it to several years back. I do think Dr. Mancuso's work should continue to be supported. I think every view should come out. We need all views on this complex issue. The final answer is not here. I can say a lot more about that later.

I would like to read my prepared statement. My conscience will be clear. My father, may he rest in peace, will know I did what I could for my country. I will just read what is here, so I won't put any more feet in my mouth.

It is particularly important, since I am employed by a Federal regulatory agency, to make it very clear that this testimony is based only on my personal opinion and does not necessarily reflect any views of other members of the Nuclear Regulatory Commission (NRC) or any policies of that Commission. In fact, I feel that NRC policies will continue to take into consideration all views and information relevant to the biological effects of radiation, as expressed in these hearings and elsewhere.

Further, my personal opinions in regard to the Mancuso-Stewart-Kneale (1) paper are based purely on my own knowledge from working with Dr. Mancuso and Dr. Barkev Sanders during the origination and first 8 years of the health and mortality study, my prior knowledge and training in both radiation measurements and the analysis of health studies, and on a reading of the subject paper by Mancuso, Stewart, and Kneale. (1) Also, I am here on leave from my current position, and am thus appearing at my own expense. I wish to make it clear also that on one at NRC has attempted to influence my remarks.

In fact, I even had trouble having some of these people discuss it with me because they were afraid I might be influenced or I might think I was.

I appreciate the opportunity to present my views to Congress since I believe these issues to be in urgent need of legislative attention. However, this is an unhappy circumstance for me, since one of the main purposes of my present testimony is to discredit the current claims by Mancuso, Stewart, and Kneale to have found cancers that are proven to have resulted from low-level radiation. I have mentioned in documents submitted as part of this testimony the important prior contributions of Dr. Mancuso and Dr. Stewart in discovering and alerting society to hazards of exposure to certain chemicals and to X-rays received by fetuses in utero. It is ironic that I must now point out the absurdity of the present paper by Mancuso, Stewart, and Kneale. (1) I don't know whether Dr. Mancuso remembers this or not, but among the many people I recommended to him for his advisory committee was Dr. Alice Stewart, because I knew she was brilliant in thinking of many ways to look at data; and Karl Morgan in the audience, is another one of those people I recommended, as well as his fine associate, Dr. Walter Snyder.

Mr. **Carter**. I must agree, they are two of the greatest.

Mr. **Brodsky**. They are still among my heroes. I hope they do not look down upon me too much for this testimony. I do this only because Drs. Mancuso and Stewart have not only published, but have widely publicized their claimed findings, and I feel that it will be a dangerous precedent in our democratic society if claims of important health effects can be given credence on the basis of such preposterous distortions of scientific method as are utilized in this particular paper by Mancuso, Stewart, and Kneale.

I want to make this very strong. These are my beliefs. It is difficult enough for Congress to deal with the complex health issues of our society even when they have the facts; they do not need fallacies.

The retrospective methods as used in the Mancuso paper could, at most, be used as a basis for providing hints of radiation effects, if the analyses had been properly carried out, considering effects of all exposures and factors; yet they have been put forth as a basis for strong conclusions of proven cancer causation. These methods bear no resemblance to those developed by Dr. Mancuso, Dr. Sanders, and myself for a detailed prospective study. (2, 3) This has been called a longitudinal-type study by Dr. Gilbert; it is the same type of thing I am talking about, where you actually look at incidence rates of cancer—involving comparisons of the actual cancer rates and mortality experience of many population subgroups compared to several control or comparison populations of interest, matched by numerous pertinent demographic, employment, and dose variables. Why did Dr. Mancuso not utilize the data and statistical methods that we developed with millions of dollars of public funds? Why did he turn instead, at the last minute, to Dr. Alice Stewart and Mr. Kneale for a rapid, limited retrospective analysis that ignores many of the important variables and analytical techniques initially deemed essential by Dr. Mancuso himself?

But also, if you look at this paper carefully, although they mentioned 21,000 population or so—I know from the work on this study we spent millions of dollars collecting data on these 21,000—if you look at the paper the only portion of the data that is used is that on population deaths. This is a waste of public funds if the actual cancer rates are not studied further. I think it should be pursued further by Dr. Mancuso, as well as by other independent investigators. A summary of my conclusions is given in the statement provided to the committee. Here is my summary. I may skip some of this because you have it before you.

If I am talking too long, just tell me to shut up.

I hope that Members of Congress, their staffs, and others will read and examine a few of the simple examples of absurdities of the Mancuso-Stewart-Kneale paper (1) as pointed out in my submitted critique. (4)

One does not need higher mathematics or esoteric statistical techniques to see the fallacies of their methods. I am not against mathematics or against statistical techniques. I taught biostatistics and epidemiology at Duquesne University.

Mr. CARTER. Tremendous, but what do you think of common sense?

Dr. BRODSKY. That is what I am talking about. if you read my other comments that I have deposited for the record, you will be able to see these things and figure them out and draw your own conclusions.

I find that the subject paper (1) by Mancuso, Stewart, and Kneale contains strong conclusions regarding the proof of cancer causation by low-level radiation exposure; in my opinion, these conclusions are not at all justified by the data and analysis presented. Proper methods of conducting such a study are reviewed in many volumes of reports of Dr. Mancuso's project. (2)

I have given references to those reports, on the first eight of which I was the coauthor. I did much of the writing, and Dr. Mancuso appreciated that.

One method I presented for analyzing longevity and comparing it—each specific age, sex, race, and employment cohort—with that of controls showed that there was a striking similarity in mortality experience between Hanford employees versus matched controls of siblings, when both were taken from families of two or more offspring. (5)

I mention this because I think this is one approach that may be tried for a logitudinal study, and I want to make it available. Dr. Mancuso did not let me publish this in our publication in 1971 in detail. There are some conclusions there. I think this method may be overlooked. But it is not the only method that could be used to carry out a proper prospective analysis.

Neither the result nor the possibility of conducting this type of prospective comparison for various radiation dose levels and causes of death is even mentioned in the present Mancuso-Stewart-Kneale paper (1) although my result was in confirmation of similar analyses by Dr. Barkev Sanders, who unfortunately is not here today. During the 8 years I participated with Dr. Mancuso in this study, I supported the ideas that we developed mutually with Dr. Sanders, and I still support those ideas, many of which originated with Dr. Mancuso himself. I learned much from Dr. Mancuso about epidemiological study; maybe not as much as he knows, but on the other hand, maybe I learned something more about quantitative analysis.

I will thus not speak further at this time regarding proper methods of carrying out a radiation epidemiological study.

For brevity, I will merely cite some examples to illustrate the kinds of logical errors present in the Mancuso-Stewart-Kneale paper. First, it should be noted that nowhere in this entire paper is there a mortality rate of cancer calculated and compared with a corresponding rate in a suitable control population of interest. A mortality rate is the number of cases of death by a specific cause, divided by the total population at risk, per year, standardized for age or calculated for a specific age group, and usually multiplied by 100,000 to obtain the rates per 100,000 population.

Certainly the conclusions of this paper are not based on incidence rates. That has been used many times in the hearing. People have said that Mancuso-Stewart-Kneale have shown greater incidence rates. Mancuso, Stewart, and Kneale did not calculate incidence rates. They have been calculating the radiation exposures of those who died from cancer versus radiation exposures of those who did not die of cancer but died of other causes. That is not an incidence rate. That is a different thing.

Second, it should also be noted that no proper control population is actually included in this analysis, although such populations were constructed by Dr. Mancuso, Dr. Sanders, and myself as an originally essential part of the project?

Dr. Mancuso and Dr. Sanders did most of the work on that construction. I do not want to take anything away from that.

The entire analysis of the present paper involves merely the exminations of slight differences in average occupational exposures of those who died of cancer and those who died of other causes. When all comparisons of the paper are taken together, even the small differences in occupational exposure, which occur for certain years and certain ways in which the data are arranged, are neither, in my opinion, scientifically nor statistically significant, despite the strong assertions of Mancuso, et al. (1)

Further, in most of the tables of data, there are obvious reasons why those who die of cancer might have somewhat higher occupational radiation exposures than those who die of other causes, without there needing to be any connection whatsoever between radiation as a causative agent and cancer.

For example, consider the fact, obvious to anyone, that persons dying of cancer die at an advanced age, while those dying of automobile accidents usually die at an earlier age. Thus, it might be expected that those who died of cancer at Hanford worked somewhat longer, on the average, and thus were there longer to accumulate a bit more radiation exposure.

It should also be noted that Mancuso, et al., (1) have not mentioned the considerable confounding influences that could completely erase the so-called findings if magnitudes and variations of the following types of additional exposure were considered: Known medical exposures, (6) exposures in plants other than Hanford, and exposures to other carcinogenic agents of the work environment—all of these are agents that Dr. Mancuso insisted must be considered in any analysis of the project data during the 8 years I was associated with him. [See progress reports. (2)]

As a final example of the absurdities of the Mancuso-Stewart-Kneale paper, let me merely quote the following paragraph from my January 12 memorandum (4):

> Furthermore, note that the authors coin a terminology "high risk" year to denote any year where the average radiation dose to members of the cancer death group is even slightly greater than that of the noncancer group. First of all, they are confusing dose with risk (or response). Second, they are presuming what they are trying to prove. Third, to show how preposterous and unscientific this is, note that for all years in Table 5, the averages to be compared (for 1944-57) are merely 199

millirem per year for the cancer-death group, and 187 millirem per year for the noncancer deaths; for 1958-72, the respective averages are 518 versus 477 millirem per year. (The authors do not state whether their averaging calculation was weighted by the number of employees alive each year.) Considering that each year an employee must receive (a variable) 100-150 mrem per year from natural background radiation (including natural activity in his body), as well as the (again variable) 39 millirem per year average from diagnostic medical exposures as cited earlier (which as everyone knows can vary for an individual from 0 if he did not have an X-ray that year up to many hundreds of millirem), then comparison of the average dose in Table 5 makes it clear that they are effectively the same between cancer deaths and noncancer deaths, i.e., known other types of exposure, including occupational exposures at other facilities than Hanford, could obviously obscure such small differences in average occupational exposure at Hanford between the cancer and noncancer groups, if they had been reported. Dr. Mancuso had also on many previous occasions emphasized that conclusions regarding radiation effects could never be drawn without examining possible effects of chemical agents in the work environment. Chemical agents are not even mentioned in the present paper.

Look at table 5 of the Mancuso-Stuart-Kneale paper. [See p. 589.] Don't believe a word I have said today if you don't want to. Just do me a favor and read that paper and look at what I have said in that one paragraph and you convince yourselves. you don't have to be a health physicist. You don't have to be an epidemiologist. Here is where the commonsense comes in that Dr. Carter was talking about. This is commonsense we are talking about; is that right?

Mr. CARTER. That is the rarest of all commodities.

Dr. BRODSKY. I want to state a few recommendations, very briefly. I think I have a lot to say about what Congress can do about all this mess. I tried to put a few things in very brief form just to bring your attention to them. If you want to read further, there is a little bit more. I can say a lot more at other times; free, no charge.

Some day history will say that Dr. Allen Brodsky, in 1978, said: "I regret that I have only one job to give to my country."

Recommendations to Congress: Some recommendations are in order regarding national needs for better planning and organization of health studies of the effects of agents, drugs, or chemicals to which populations of our citizens are exposed. I can list here only a few of my concerns and hope that they will receive more detailed consideration at a later time.

One, an independent national group of eminent scientists and health professionals is needed to quality control and test results of radiation health studies and provide direct guidance and judgments to Congress as well as the administration. This does not have to be a large group, nor should it interfere with the independence and replication of investigations by others.

However, this matter requires the support of appropriate legislation and the implementation by a broad group of health professionals and scientists cognizant of all the areas of data and statistical analysis involved. One possibility would be to organize such a group under the auspices of the Committee on Biological Effects of Ionizing Radiation, National Academy of Sciences. Harold T. Peterson, USNRC, has spelled out some further ideas related to this suggestion. I believe one of the early functions of such a group should be to establish a set of rules, analogous in purpose to Koch's postulates in microbiology, that place certain conditions on epidemiologic studies before any claims of proof of scientific findings can be made.

I have developed the concepts of this need in a number of the Mancuso project reports in terms of the needs of radiation epidemiology. The chi-square test that I developed and reported at the 1971 Health Physics Society meeting, (2, 5) was an outcome of my attempts to show one way in which large epidemiologic studies should be tested both to find out whether the overall differences in mortality in many subgroups of a total study are significant, as well as to provide an objective method of highlighting those subgroups of a population where real effects might occur but not be observed if the data were merely pooled for a larger population in order to observe small effects of low doses.

The result of this test was striking, and the chi-square statistic employed was validated as an adequate approximation to the chi-square—one degree of freedom—function. (5) Nothing is magic about my method, but it could serve as a point for beginning discussions on this subject of quality control of radiation epidemiologic studies.

Two, each agency should maintain permanent record systems of radiation exposures of those populations under its protection and should also maintain appropriate data to carry out annual health evaluations of these populations as part of its auditing program to understand and evaluate the long-range accomplishments and/or adequacy of its programs. This recommendation is consistent with Dr. Mancuso's often-stated principle that any health study must be carried out in conjunction with those who know the data best.

I think what happened here, he was pressured—because DOE and ERDA, unfortunately, took the project away from him prematurely—to do a retrospective analysis only. He always said he did not want to do a retrospective analysis only. I hope he will have an opportunity to do the analyses as originally planned.

Present agency programs do not begin to adequately approach this need. The costs involved will not be appreciable, nor would privacy be violated if the programs are properly organized and supervised and designed to incorporate currently related studies. I think we need some help from Congress, too.

Three, each agency responsible for the protection of public health and safety should maintain an advisory committee or advisory staff composed of outstanding health scientists and professionals as well as those who understand the engineering methodology of controlling the agents of concern, in order to give a balanced evaluation of programs and policies of that agency as they affect the health and mortality of populations under their protection.

Some of these recommendations are expounded in more detail in reference 4.

[Testimony resumes on p. 899.]

[Dr. Brodsky's attachments follow:]

REFERENCES

1. T. F. Mancuso, A. Stewart, and G. Kneale, "Radiation Exposures of Hanford Workers Dying from Cancer and Other Causes" (University of Pittsburgh, Pittsburgh, Pennsylvania 15261), Health Physics 33, pp 369-385, 1977.

2. T. F. Mancuso, B. S. Sanders, and A. Brodsky, "Study of the Lifetime Health and Mortality Experience of Employees of AEC Contractors, Part I: Methodology and Some Preliminary Findings Limited to Mortality for Hanford Employees," in Radiation Protection Standards: Quo Vadis, COO-3428-1, Proceedings of the Sixth Annual Health Physics Society Topical Symposium, November 2-5, 1971, Vol. III, published by the Columbia Chapter, Health Physics Society, 1972; see also the eight previous annual progress reports by the same authors. These should be available from Dr. T. F. Mancuso, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pennsylvania 15261.

3. Letter to Dr. T. F. Mancuso from Dr. A. Brodsky dated 2/1/78.

4. Memorandum to J. Kastner, Chief, Environmental Standards Branch, Office of Standards Development, from A. Brodsky, Senior Health Physicist, Occupational Health Standards Branch, Office of Standards Development, USNRC, Washington, D.C. 20555, entitled "Comments on Published Version of Paper by Mancuso, Stewart, and Kneale," dated January 12, 1978.

5. A. Brodsky, "Testing Differences in Life Years Lived and in Cumulative Mortality for Each and for All Age-Cohort Subgroups,"* in T. F. Mancuso, B. S. Sanders, and A. Brodsky, NYO-3394-13, Progress Report No. 7, Study of the Lifetime Health and Mortality Experience of Employees of AEC Contractors, 1971, pp IV-115 to IV-190; see also reference 2, Appendix A, pp 143-144, for a summary comparison of the results of the independent longitudinal analyses by Drs. Barkev Sanders and A. Brodsky.

6. W. D. Norwood, F. L. Rising, C. W. Kirklin, A. Brodsky, B. S. Sanders, and T. F. Mancuso, "Cumulative Dose from Diagnostic Radiation,' Am. J. Roentgenol., Radium Ther., and Nuclear Med. CXV, 644-648, 1972.

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* The article referred to may be found in the subcommittee files.

Reference 3
A. Brodsky

C O P Y

Office of Standards Development
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
February 1, 1978

Dr. Thomas F. Mancuso
Research Professor
Graduate School of Public Health
University of Pittsburgh
Pittsburgh, PA 15261

Dear Tom:

Thank you for your letter of January 23, 1978, enclosing some answers to particular written criticisms of your analyses of the Hanford population data. I have begun reading the material you sent, but have not had time to fully digest it so far. I think you know, as I have mentioned before, that I am assigned full time to work on guides that I feel are important in reducing radiation exposure to employees, and am using only part of my own time to examine current epidemiologic results.

However, I have written a critique of part of your paper with Alice Stewart and George Kneale, as published in the November 1978 issue of Health Physics, based only on what I have read in the paper itself and upon some of my own knowledge of the data. Since my written comments on your paper are detrimental to your current scientific position and I have made them available to the congressional committee before which you are to appear next week, I am forwarding a copy of my comments to you now although my review is not entirely complete. I feel very strongly, as I have stated to you personally, and as you initially stated to me, that a retrospective analysis of the kind carried out in the November paper cannot serve as a basis for the kind of strong conclusions that you and your co-authors have published and publicized.

Although George Kneale is obviously a very competent mathematical statistician, and the mathematical derivations are probably correct under the assumptions given (I have checked some derivations but not all as yet), unfortunately the treatment of all possible causes of cancer is not included in the analysis and thus certain important terms do not appear. Moreover, a Bayesian approach to obtaining a formula for the association between having cancer and having received radiation is certainly no basis for asserting any proof of causation; I believe that common if not scientific sense should make this clear. Please read my comments on part of the paper to see some simpler problems that should make the paper obviously absurd to any scientist who knows anything about the magnitudes of occupational radiation exposures at Hanford, their distributions, and the other exposures such as exposures at other sites, medical exposures (on which we carried out a pilot study described in one of our reports and cited in our publication by Norwood et al), and other chemical agents in the environment. During all the years I worked with you, and in all of the progress reports that we wrote together with Barkev Sanders in those years, we all agreed and you insisted that any published results of this study must consider these other exposures and at least discuss any effects (positive or negative) of these other exposures (known and unknown) on the outcomes of mortality and morbidity analyses. I do not understand your complete turnaround in publishing, or allowing Alice Stewart to write for publication, a strong claim of findings without even the proper mention of these other agents of environmental exposure. There are further absurdities as indicated in the enclosed comments. The net result of all of this is to indicate, as I have done in my enclosed comments, that you and your co-authors do not constitute an adequate investigatory team to carry out the analysis of this type of project by yourselves, although your individual expertise, dedication, and past contributions to the discovery of agents of chronic disease in industry and medicine should never be forgotten. The problem is, here again, one that you yourself expounded during the eight years I worked with you: any such investigation should be conducted, and evaluated, together with those who know the data best. Also, Alice Stewart's retrospective methods, while necessary and valuable in her studies of childhood cancer originating from diagnostic medical irradiation, are obviously not adequate here for this type of situation and the number of confounding variables involved in a purely retrospective evaluation.

As you must realize, it has been emotionally as well as intellectually difficult for me to observe the analysis presented at the 1976 Saratoga Springs meeting and your subsequent revisions up to the publication in Health Physics. It is especially painful for me to find myself in a position where I must privately and publicly expose the absurdity of your present work. I do believe that you have shown great leadership in occupational health previously, and have contributed many good ideas and recommendations, some of which both Barkev Sanders and I supported as evidenced in our many progress reports and proposals written together. To the extent I can, I will continue to support the proper epidemiologic investigation of the health status of workers, using nationally organized health statistics as you have so often urged. I believe that it was a mistake for ERDA to exclude you from further pursuit of your work on the health and mortality study by completely removing your funds. I hope that you will somehow be brought back into this work by the government for the knowledge and dedication that you do possess; but I believe that appropriate analyses of the collected data are also necessary by independent and appropriately broad-based teams, as I have recommended previously. I also hope that future investigators will have the vision (and lack the jealous possession of data) to avail themselves of the special knowledge and ideas that Dr. Barkev Sanders brought to our project, recognizing the unfortunate personality conflicts that have arisen between you and him. Much of public funds was expended in collecting the data you summarized in your progress report, and the progress of our project toward an appropriately evaluated prospective study should not be wasted. If properly supervised and managed, the additional expenditures to carry it forward should be small compared to expenditures already made.

Since it is more important that you receive this material in time for review this weekend, since I have other work pending today, and since the ideas expressed in this letter are purely my own and have been written on the basis of knowledge and experience gained before coming to NRC, I hope you will forgive my sending this rough draft to you today. Time for typing and approvals would work to your disadvantage, and would unfortunately not sweeten this message to you. I am also enclosing a copy of the document on radiation safety in medical institutions (keeping exposures as low as reasonably achievable), which I mentioned to you I was working on. This was recently published for comment, along with a Regulatory Guide. I know you will enjoy reading these documents, and would appreciate any suggestions you may have for their improvement.

Best wishes,

/ s /

Allen Brodsky, Sc.D.
Senior Health Physicist

Enclosures:
A. Memo of comment
B. NUREG-0267 and Reg Guide 8.18

cc: Public Document Room, with Encl A
R.B. Minogue
R.G. Smith
I.C. Roberts
R.E. Alexander
J. Kastner
M. Parsont
S. Levine
F. Swanberg

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

Reference 4
A. Brodsky

January 12, 1978

MEMORANDUM FOR: Jacob Kastner, SD:ESB

FROM: Allen Brodsky, SD:OHSB

SUBJECT: COMMENTS ON PUBLISHED VERSION OF PAPER BY MANCUSO, STEWART, AND KNEALE[1]

In reply to your request, I have reviewed the referenced paper as published in the Health Physics Journal, November issue. This published version is identical to the one submitted to me by you as a section of Dr. Mancuso's last progress report. The progress report includes some introductory opinions of Dr. Mancuso and some brief review of the history of data collection and selection of data, which have been abstracted from previous progress reports. I deem it is only pertinent to comment on the analysis itself.

Since I have a number of statements to make regarding this paper, I am giving only my main conclusion below and am attaching a detailed summary of my findings, which include: a Preface, giving some of my own opinions as well as facts necessary to put my comments into perspective; a section of detailed comments on the paper, which presents facts and observations to support my conclusion below; and a final section on recommendations, which includes my own opinions of further action that should be taken by NRC in view of the national impact of this Mancuso paper, its recent attention in the press, and the nature of the problem.

Conclusion: As supported by the attached evaluation, I find that the subject paper by Mancuso, Stewart, and Kneale contains strong conclusions regarding the proof of cancer causation by low-level radiation exposure; these conclusions are not at all supported by the kind of analysis and data presented. In my opinion, the paper has so many absurdities that it can serve to prove only that the authors, although reputable for certain previous efforts in epidemiology, do not comprise a team of sufficient breadth of scientific competence by themselves to be able to evaluate the types of data involved in a radiation epidemiological study of this nature.

Allen Brodsky, Sc.D.
Allen Brodsky
Occupational Health Standards Branch

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[1] T. F. Mancuso, A. Stewart, and G. Kneale, "Radiation Exposures of Hanford Workers Dying from Cancer and Other Causes," University of Pittsburgh, Pittsburgh, Pennsylvania 15261, Health Physics 33, pp 369-385, 1977.

Dr. A. Brodsky
January 12, 1978

EVALUATION OF PAPER BY MANCUSO, STEWART, AND KNEALE(1)

I. Preface

This preface of my position and opinions is now necessary for the following reasons:

(a) As a result of my earlier conclusions of the invalidity of the Mancuso-Stewart-Kneale approach, as reported in 1975 at the Saratoga Spring, N. Y., meeting of the Health Physics Society, the publication of my views along with the earlier NRC statement, and other direct and indirect statements, both public and private, my name, reputation, and previous work with Dr. Mancuso may be somewhat at issue here.

(b) My review of their final publication(1) again compels me to issue a rather strong rejection of their paper, particularly in view of Dr. Mancuso's and Dr. Stewart's public promotion of their own invalid conclusions as accepted scientific findings.

(c) The paper by Mancuso, et al has already received national and international press and TV publicity, with the encouragement and participation of Drs. Mancuso and Stewart, who claim their "findings" as accepted truth.

(d) The effects of a public belief in the claims of Drs. Mancuso and Stewart, particularly in a democracy such as ours, could have a seriously adverse effect on the public health and welfare, for the sake of promoting by scare tactics changes in radiation safety standards that could result only in an unnoticeable and undetectable decrease in risks from radiation exposure. Therefore, my rejection of this paper must be clear and emphatic.

Thus, I want to put into context my comments on the present paper(1) by simply stating that I will not accept or tolerate any further attempts to imply--directly or indirectly--that my negative comments on the Mancuso-Stewart-Kneale paper are evidence of any lack of integrity or interest on my part in optimizing radiation protection of workers and all of the public. I can provide documentation, publications, and personal witnesses to substantiate the efforts I have made for over 28 years to protect persons from unwarranted or even appreciable risks of radiation exposure. Also, I have always believed in using the most conservative estimates of risk justifiable by available data in judging the maintenance of "as low as reasonably achievable" exposures. My own theory of the stochastic nature of cell changes inducible by chemicals and/or radiation(2) to produce cancer does in fact postulate probabilities of these cell changes that are finite at even the lowest dose levels, so my personal belief in the need to minimize unnecessary radiation exposure is further substantiated. I do not doubt that some of the cancer deaths may have been caused, in part or in toto, by radiation exposure, just as many of these were probably caused by non-radiation carcinogens in the work and non-work environments, or by "spontaneous" mutations. However, the Mancuso-Stewart-Kneale claim to have calculated meaningful doubling doses, and estimates of probabilities of cancer that differ from previous risk estimates of the National Academy of Sciences committees, is based on invalid methods of analysis as indicated in Section II below.

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(1) T. F. Mancuso, A. Stewart, and G. Kneale, "Radiation Exposures of Hanford Workers Dying from Cancer and Other Causes," Univ. of Pittsburgh, Pittsburgh, Pa. 15261, Health Physics 33, pp. 369-385, 1977.

Further, I wish to make it clear that I have no personal reasons to be prejudiced against Dr. Mancuso's or Dr. Stewart's findings. I respect Dr. Mancuso for his dedication and for his competence as a physician in epidemiology--but not as an analyst of quantitative data, which are the final results of an epidemiological study. Also, Dr. Mancuso treated me well when he kept me as a co-investigator on this project for 8 years, and I am grateful for his initiation of the letter in 1966 that resulted in my tenure appointment as Associate Professor at the Graduate School of Public Health, University of Pittsburgh. During the 1960's, I also supported the recognition of Dr. Alice Stewart's work, in many replicated studies, that made it prudent for us to accept her estimates of the incidence of childhood leukemia as induced by x-raying of the fetus in utero. Her achievements in these studies have been justifiably commended. In fact, I informed Dr. Mancuso of her work and recommended her as one of the members of the Advisory Committee for our project. But the nature and quantity of data collected in her surveys of British hospitals was much different than that of the present report.(1)

Thus, let me state for the record that I will not accept any assertions I am biased against the authors, nor against valid findings of radiation effects. It is an unhappy circumstance for me that I find myself obliged to prepare such a negative review of Dr. Mancuso's and Dr. Stewart's work, and I have hesitated to write these comments.

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(2) Allen Brodsky, "A Stochastic Model of Carcinogenesis Incorporating Certain Observations from Chemical and Radiation Dose-Response Data," Health Physics, in press, 1978.

With this preface, I will try to limit Section II to some factual observations about the Mancuso et al paper. In most cases, these factual observations should be understandable and verifiable by any intelligent person, without prior training in radiological or biostatistical sciences, simply by a careful scrutiny of the subject paper.(1) Finally, some further opinions of this reviewer will be presented in Section III.

II. Detailed Comments and Observations

1. Before I deal with specific examples of the many scientific absurdities of this paper I should point out very emphatically that nowhere in this entire paper is there a mortality rate* of cancer, or any of the defined ICD coded neoplasms, calculated and compared with a corresponding rate in a suitable "control" population of interest. It should also be noted that no proper control population is actually included in this analysis. Further, no statistical information such as age distributions, etc., of the 24,939 employees listed as studied in the paper (Table 1) are given so that the reader may himself properly standardize for age, etc., and at least make his own calculations of age specific cancer rates among Hanford workers for comparison with other groups. This paper ignores the vast majority of the data collected on the base populations by Drs. Mancuso, Sanders, and myself at millions of dollars of taxpayers' expense, and ignores commitments of Dr. Mancuso in his previous reports to carry out a proper prospective analysis of the data, using several specified and available control groups.(3) The entire "analysis" of the present paper involved merely the examinations of slight differences in average occupational exposures of those who died of cancer and those who died of other causes. It will be shown why, in further comments below, that even these small differences in occupational exposure are neither scientifically nor statistically significant, despite the strong assertions of Mancuso et al.

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(3) T. F. Mancuso, B. S. Sanders, and A. Brodsky, "Study of the Lifetime Health and Mortality Experience of Employees of AEC Contractors, Part I: Methodology and Some Preliminary Findings Limited to Mortality for Hanford Employees," in Radiation Protection Standards: Quo Vadis, COO-3428-1, Proceedings of the Sixth Annual Health Physics Society Topical Symposium, Nov. 2-5, 1971, Vol. III, published by the Columbia Chapter, Health Physics Society, 1972.

*A mortality rate is the number of cases of death by a specific cause, divided by the total population at risk, per year, standardized for age or calculated for a specific age group and usually multiplied by 100,000 to obtain the rates per 100,000 population.

Further, even if there were statistically significant, and consistently greater differences in average radiation exposure for those who died of cancer, this would not be a conclusive proof that radiation caused a higher rate of cancer among these workers than would be found among a comparable group of workers in other industries, since there are many non-causative reasons that the average radiation dose could be higher among the cancer deaths. (There is, in fact, repeated evidence in the data of the paper that non-cancer deaths occurred somewhat earlier in the employee's life (as expected, since cancer rates increase with age), thus not allowing them to accumulate as much radiation exposure, on the average.)

I believe that the authors have confused two conditional probabilities: the conditional probability that a worker will develop cancer given that he has received radiation exposure is not the same as the conditional probability that a worker will be found to have had a slightly higher recorded occupational exposure given that he has already died of cancer. The latter type of conditional probability is the one being estimated in essence, in a retrospective type of analysis of the kind attempted by Mancuso et al.(1) This retrospective type of analysis can never be taken to prove causality, because increases in actual cancer rates are not really calculated at all, and thus cannot be shown to follow radiation exposure in the appropriate time sequence, cannot be shown to increase with increased radiation exposure, and cannot be compared with cancer rates from other comparison populations. The several ways in which the authors(1) have arranged the data, e.g., according to calendar year of exposure, employment year, etc., cannot be taken to be independent evaluations since all of the other factors are in each case confounded and mixed together in the same population. (Some of these factors may themselves be correlated with radiation exposure and would thus be expected to cause a somewhat increased average exposure among the cancer deaths for several ways of arranging the data.)

If the authors were truly interested in determining whether there was a real difference in cancer mortality among Hanford workers compared to appropriate controls, why did they not try the prospective analyses of each cohort (people who enter into employment in a given year) where employees of certain age, sex, race, etc., could also be broken down into sub-groups for comparison against like sub-groups in control populations? Also, in a prospective analysis the sums of years lived for each employee could also be calculated. (Cumulative life-years lived would be more sensitive for detection of overall mortality effects from all causes than the counting of cancer deaths alone.) Two independent analyses were already programmed, tested, and used for Dr. Mancuso in a previously reported preliminary analysis of gross mortality experience at Hanford by Dr. Barkev Sanders(4,5) and by myself.(6,7) The findings of my analysis basically corroborated those of Dr. Sanders, and I stated that "...several different statistical tests and calculations have indicated that the gross mortality of Hanford employees, when compared with similar constraints in regard to age distribution, sex and race, does not differ significantly from the sibling control population."(6) Although the analysis was admittedly preliminary, it was still much more proper than any of those of the present paper,(1) and carried out in such a way that known errors or omissions would tend to be distributed randomly and with equal probability between the compared respective employee and control subgroups. Why was this result, and the methodology, not even mentioned by Drs. Mancuso and Stewart, either in the discussion of their paper(1) or in their announcement to the press?

If the authors(1) could not understand or trust the methods made available by Dr. Sanders and by me, and computerized by Howard Fore at the Oak Ridge Computer Technology Center, then why did they not utilize at least the statistical methodology for evaluating employee mortality data vs. controls, as developed for Dr. Mancuso by Dr. Carol K. Redmond and Mr. Arthur A. LeGasse, Department of Biostatistics, University of Pittsburgh(8)?

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[4] T. F. Mancuso et al. in Radiation Protection Standards: Quo Vadis, op. cit., pp. 23-140.

[5] Barkev S. Sanders, "Discussion of Some Prepreliminary Mortality Experience for Hanford Employees and Certain Controls," in Study of the Lifetime Health and Mortality Experience of Employees of AEC Contractors, by T. F. Mancuso, B. S. Sanders, and A. Brodsky, Progress Report No. 7, NYO-3394-13, 1971, pp. IV-1 to IV-114.

[6] T. F. Mancuso et al., in Radiation Protection Standards: Quo Vadis, op.cit., 1972, pp. IV-115 to IV-116.

[7] A. Brodsky, "Testing Differences in Life Years Lived and in Cumulative Mortality for Each and for All Age-Cohort Subgroups" in T. F. Mancuso et al., NYO-3394-13, op. cit., 1971, pp. IV-115 to IV-190.

[8] Carol K. Redmond and Arthur A. LeGasse, in NYO-3394-13, 1971, op. cit., pp. IV-191 to IV-207.

All of the above methodologies of Dr. Sanders, myself, Dr. Redmond and Mr. LeGasse were available to Dr. Mancuso and have been tested, with some rather striking results, in the preliminary studies. None of these methodologies for comparing actual cancer rates with those of controls have been mentioned or utilized in the subject paper.(1) (Is this so because the results were negative?) Further, Dr. Sanders who was dismissed as the project statistician only about 2 years ago, has submitted his own analysis of the Hanford data for publication,(9) which includes a table prospectively analyzing the mortality data. Dr. Sanders' results indicate essentially no difference in cancer mortality between Hanford workers and controls, that can be attributed to radiation. Although Dr. Mancuso had access to early versions of Dr. Sanders' analyses, these are also not mentioned in the present paper.(1) A study, in order to be scientific must be repeatable by different investigators. Epidemiological studies--with the many uncontrolled variables that can affect the health of a human population--must be properly done and replicated in different ways by different investigators. Instead, the authors of the present paper do not even attempt to compare their "findings" with other investigators' work before leaping to strong conclusions from weak data, improperly evaluated.

Finally, if for some reason the authors felt constrained to avoid all previous analytical methods, and there was no time to develop a new program for retrospective analysis only, then why did they not try to test the ranking of individual doses from each cancer death with the individual doses of the non-cancer deaths for each of their ways of grouping the data?

This would have been more appropriate than dealing only with averages (which will be shown later not to be significantly different). The testing of ranks of individual exposures should also have been more sensitive to real differences in dose distribution between cancer and non-cancer deaths, if present, than testing the rankings of small differences in average dose between broad groupings. Anyone who knows the magnitudes, and their variations, of the natural background radiation and/or medical exposure, over the years cumulated by the workers during radiation monitoring would see that the small differences in average dose would be made completely insignificant if other radiation exposures alone were included in the study. Indeed, the average medical exposure of a sample of Hanford employees, for the 1946-56 period, was measured to be 39 mrem (3.9 "centirads" in the Mancuso-Stewart-Kneale terminology), weighted by the mass of tissue exposed as indicated by the x-ray films re-examined for this study.(10) This means that for an average period of monitoring at Hanford of about 6 years, an additional

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[9] B. S. Sanders, "Low-Level Radiation and Cancer Deaths," Health Physics, in press, 1978.

[10] W. D. Norwood, F. L. Rising, C. W. Kirklin, A. Brodsky, B. S. Sanders, and T. F. Mancuso, "Cumulative Dose from Diagnostic Radiation," Am. J. Roentgenol., Radium Ther., and Nuclear Med. CXV, 644-648, 1972.

medical exposure of about 240 millirems was incurred per employee. No mention is made by the authors(1) of the possible confounding of their "results" by this medical exposure and its variations, in view of the small differences in group average doses that they deem significant. However, Dr. Sanders (Reference 3, p. 31) did show from the pilot study of medical exposures at Hanford (1946-56), the medical exposures would not change the ranking of individual occupational exposures very much.(3)

2. Improper and misleading terminology is used throughout the paper, indicating the authors' unfamiliarity with the radiation dose data examined in the study. For example, on page 369, first column,(1) eighth line from the bottom, the authors state "In several high risk occupations the workers are also examined (at regular intervals and following accidents or radiation 'leaks') for internal depositions of radioactive substances." This implies that all employees included in the Hanford bioassay program were subjected to "high risk occupations." This assertion by itself, occurring so early in the paper, indicates the authors' initial bias that any exposure, no matter how small, results in a "high" risk. The authors apparently do not realize that there is a wide frequency distribution of internal exposures at Hanford, most of which lie below a median to which no knowledgeable scientist in this field would attach a "high risk." Internal exposures, converted to units of dose equivalent when the necessary calculational models are available, are generally an extremely small fraction of the external doses listed in the paper, which presumably are the only doses used in the authors'(1) analyses. For adequate study of the effects of internal exposure, the known cases of significant exposure must be separated out and examined carefully in regard to all applicable variables and medical findings, as originally planned by Dr. Mancuso and his colleagues. No mention is made in the current paper(1) of the recognized difficulties (Reference 3, p. 179) of combining internal and external exposure--as well as other uncertain, unknown, and variable exposures--into a single analysis of the data.

3. On p. 369 of the paper,(1) the statement "Radiation monitoring has been in operation since 1943..." is wrong. This has been corrected to 1944 in the copy of the manuscript included with Dr. Mancuso's final progress report.(11)

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(11) T. F. Mancuso, "Study of the Lifetime Health and Mortality Experience of Employees of ERDA Contractors," COO-3428-8, Final Report #13, Department of Industrial Environmental Health Sciences, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pennsylvania 15261, Sept. 30, 1977.

4. In the third paragraph of page 370, the authors introduce their Table 2, which shows that the proportion of exposed workers (one or more positive badge readings) was 66% for the cancer death group and 61% for the non-cancer deaths. As indicated before, with all ages and cohorts mixed together in each death group, this comparison is meaningless; the larger proportion of radiation exposures in the cancer-death group is probably due to a higher average age at death, and a longer employment and exposure period, and is probably a consequence of the fact that accidental deaths are relatively high compared to cancer deaths in lower age groups. Even so, the difference in proportions between 66% and 61%, and certainly the difference in average doses, is not striking statistically, as shown in my comments(12) on the initial version of this paper.

   Also, as I pointed out in my comments(12) on the initial version, "From Table 1 alone, one can compare the ratios of non-cancers to cancers for males and females, which becomes 4.25 and 2.28, respectively. Since one observes from the same Table that indeed the males have received the higher average radiation exposures, then why do they have a much lower ratio of cancer to non-cancer deaths, if this kind of proportional mortality data is presumed to be valid in showing by other computative manipulations that this data has discovered the radiogenic induction of lung cancer?" Table 1 of the original paper is now Table 2 of the publication,(1) except: it is noted that the authors have now cleverly removed the data on females (because it contradicts what they would like to be able to prove?).

5. Their Table 3, breaking down cancer deaths by type of cancer is stated to show a wide variation in average doses of those dying from specific diseases. Again, the lower average dose for accidental death is to be expected, since they die at a younger age on the average. Nothing is presented to show that the rest of this wide distribution has any relationship to radiation carcinogenesis as opposed to other sources of stochastic variation in the data. The dose data are available on the project tapes, but no data are presented regarding the degree of dose variability within the groups presented in the paper.(1)

6. In Table 4, the authors do attempt to compare the Hanford deaths to a "control" population of U. S. White Males (1960). However, the

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(12) Memo, Allen Brodsky to Mike Parsont, "Review of paper by Mancuso, Stewart, and Kneale on Radiation Exposure of Hanford Workers Dying from Various Causes, October 1976," dated Nov. 1, 1976.

reader should beware, and note that the total of the "expected" deaths are not as actually taken from the authors' cited reference. The "expected" death numbers have all been normalized so that they will add up to 670, the same as the observed total cancer deaths of Hanford workers. Thus, the individual values of "Ratio, Obs:Exp" in the final column are fictitious values, and not really ratios taken by dividing actual mortality rates observed by expected rates calculated from the cited reference after standardization to the same age distribution, etc. Further, the white male U. S. population (which includes many who are already sick) is not an appropriate population for comparison to the Hanford worker population--as emphasized to me by Dr. Mancuso himself a number of years ago. For example, by the kind of normalization carried out in Table 4,(1) the Observed/Expected ratios might come out somewhat larger for neoplasms 1-8 simply because more persons in the U. S. white male population died earlier from other causes before these types of neoplasms could develop. This may not be so, but should have been investigated.

The type of comparisons shown in Table 4, if carried out properly, would be suggestive of clues (but not "proof") of types of cancer that might be produced by radiation. Indeed, as stated earlier, I believe that at the higher dose ranges shown in Table 4 there must be some probability that some of these cases were induced by radiation. However, as presented in Table 4, most of the "Obs:Exp" ratios for diseases 1-8 do not appear to differ significantly from 1.00 (although most are greater than 1), considering the numbers of cases involved and the chances for purely natural random sampling fluctuations. Thus, it is possible from the data as it stands that Table 4 could just as validly (or better invalidly) be used to "prove" that low-level radiation (mean cumulative doses below 100 centirads (1 rad cumulative over duration of employment)) reduces neoplasms of types 9-18 in the Hanford employee population.

7. "Controlled analyses," page 371: It must be recognized that these analyses that are stated to be "...controlled separately for five possible sources of false impressions" are not really separate and stochastically independent of each other. Only with a prospective analysis of the type mentioned previously, breaking down the population into subgroups that are relatively homogeneous with respect to all important variables at once, can a properly "controlled" study be done.

8. "Calendar years," pages 371-372: Again these results of Table 5 and Figure 1 may be explained by a slightly higher age at death for cancer deaths. Note in Table 10 that for all but one age group, the average radiation exposure of those dying of cancer is greater than those dying by accident. The cancer deaths probably came somewhat later in age, on the average, even within each age group.

Furthermore, note that the authors coin a terminology "*high risk*" year to denote any year where the average radiation dose to members of the cancer death group is even slightly greater than that of the non-cancer group. First of all, they are confusing dose with risk (or response). Second, they are presuming what they are trying to prove. Third, to show how preposterous and unscientific this is, note that for all years in Table 5, the averages to be compared (for 1944-57) are merely 199 millirem* per year for the cancer-death group, and 187 millirem per year for the non-cancer deaths; for 1958-72, the respective averages are 513 versus 477 millirem per year. (The authors do not state whether their averaging calculation was weighted by the number of employees alive each year.) Considering that each year an employee must receive (a variable) 100-150 mrem per year from natural background radiation (including natural activity in his body), as well as the (again variable) 39 millirem per year average from diagnostic medical exposures as cited earlier(10) (which as everyone knows can vary for an individual from 0 if he did not have an x-ray that year up to many hundreds of millirem), then comparison of the average doses in Table 5 makes it clear that they are effectively the same between cancer deaths and non-cancer deaths, i.e., known other types of exposure, including occupational exposures at other facilities than Hanford,(13) could obviously obscure such small differences in average occupational exposure at Hanford between the cancer and non-cancer groups, if they had been reported. Dr. Mancuso had also on many previous occasions emphasized that conclusions regarding radiation effects could never be drawn without examining possible effects of chemical agents in the work environment.(13) Chemical agents are not even mentioned in the present paper.(13)

These facts alone are sufficient to remove any credibility in any findings of this paper. They also indicate: the lack of knowledge or understanding by the authors of well-known scientific facts, even those with which they have previously been associated; and a lack of understanding of proper scientific method and terminology.

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*There is apparently an error in the text on page 372, where 14.9 is given as the dose instead of 19.9 as in Table 5.

(13) T. F. Mancuso, B. S. Sanders, and A. Brodsky, NYO-3394-13, 1971, *op. cit.*, pp. IV-3 to IV-4; see also the referenced previous progress reports of Mancuso *et al.* for more detailed discussion of the need to examine the effects of non-Hanford occupational exposures as well as chemical carcinogens in the work environment, before drawing conclusions.

The absurdity of the data presentation of Table 5 as accompanied by the assertions on pages 372-373 should be obvious to the naked eye without the necessity of statistical tests. However, for the sake of anyone who needs a test, the following calculations are presented:

t-Test of Differences in Mean Exposures at Bottom of Table 5

1944-57

It is reasonable to assume for purposes of a t-test that the means of each set of annual dose averages approximate means of sample values from a Normally-distributed variate even though they do not. The Central Limit Theorem helps us here, and a t-test would be more powerful than a non-parametric test in discerning any differences in means; this would favor Mancuso, Stewart, and Kneale.

The weighted sums of squares for the two columns, respectively are:

$$\begin{aligned} \text{Weighted } SSQ_{Ca} &= 236(26.5 - 19.9)^2 + 332(11.9 - 19.9)^2 \\ &+ 324(12.6 - 19.9)^2 + 310(12.4 - 19.9)^2 \\ &+ 301(22.2 - 19.9)^2 + 287(28.4 - 19.9)^2 \\ &+ 184(40.8 - 19.9)^2 \\ &= \underline{168{,}932} \end{aligned}$$

$$\begin{aligned} \text{Variance Between Annual Means (Ca)} &= 168{,}932 / (236 + 332 + 324 + 310 \\ &\qquad + 301 + 287 + 184) \\ &= 168{,}932/1974 = 85.58 \end{aligned}$$

$$\text{Standard Deviation Between Means} = \sqrt{85.58} = \pm\, 9.3$$

$$\begin{aligned} \text{Weighted SSQ}_{\text{non-Ca}} &= 900(26.0 - 18.7)^2 + 1267(13.2 - 18.7)^2 \\ &+ 1168(8.4 - 18.7)^2 + 1100(12.8 - 18.7)^2 \\ &+ 1118(20.2 - 18.7)^2 + 1006(23.1 - 18.7)^2 \\ &+ 567(41.6 - 18.7)^2 \\ &= 567{,}824 \end{aligned}$$

Variance Between Annual Means (Non-Ca)

$$= 567{,}824/(900 + 1267 + 1168 + 1100 + 1118 + 1006 + 567)$$

$$= 567{,}824/7126 = 79.68$$

Standard Deviation Between Non-Ca Means = ± 8.9

The following t statistic should approximate that of "Student's t" for 12 degrees of freedom:

$$t = (19.9 - 18.7)/\sqrt{\frac{85.58}{6} + \frac{79.68}{6}} = \underline{0.23}$$

Since, for 12 degrees of freedom, $t_{0.05} = 2.18$ for a two-tailed test, and $t_{0.05} = 1.78$ for a one-tailed test, either type of test would accept the null hypothesis, with open arms. Both the cancer and non-cancer group average doses are very much the same statistically, despite some purely apparent excess in the cancer death group.

1958-72 Calendar Years

Since there is obviously even less relative variability between annual means for 1958-72 than for 1944-57, the means 51.3 and 47.7 can also be considered well matched.

Thus, there is no point in further discussing the ridiculous counting of "high-risk years" in the last two columns of Table 5, Reference 1.

Conclusion: The presented analysis by Mancuso-Stewart-Kneale of Table 5 by itself invalidates any conclusions from other fluctuations observed and discussed by them in their data presentations.

III. Recommendations

In view of the international attention already given to the Mancuso-Stewart-Kneale paper(1) I feel that it is important to reiterate at this time certain recommendations:

1. The NRC should urgently initiate its own independent evaluations of the mortality experience of the Hanford worker population. This is not duplication of Department of Energy effort, since (as I have indicated earlier) replication of such studies is necessary for scientific verification. Supervision of the study would also assist NRC in developing its own independent capability for examining reported health studies. As you know, I have made a number of alternative recommendations in regard to how this can be done honestly and objectively, and by an independent and competent group of health professionals nationally recognized in the fields of radiation epidemiology and biostatistics. For one reason or another, my various recommendations have not been implemented, nor has any effective program for NRC independent studies of the health status of individuals exposed to radiation been initiated. While millions of dollars have been spent by NRC on much-needed research to better define safety parameters needed in reactor licensing or in the quality control of hardware, the NRC's research programs and technical support programs in regard to human health effects studies, which really audit the overall and most important performance of the agency in assessing its protection of employees and the public, are entirely inadequate. Also, considering the present controversy over radiation protection standards, insofar as the validity of various epidemiologic investigations and human dose-response models for estimating risk are concerned, human risks (or at least upper limits of risk) from radiation exposure must be obtained from proper biostatistical and epidemiological analysis of long-term data collected on human populations exposed to radiation.

   I recommend that studies on the identical populations of deaths as used for the Mancuso-Stewart-Kneale investigation, as well as the complete populations collected for the originally-intended prospective analyses, be immediately initiated in accordance with the recent proposal by Oak Ridge National Laboratory, as supported and modified by my recent memorandum to Robert E. Alexander. I make this recommendation urgently, since I believe that this proposal is not only the one most immediately at hand, but also meets the initial requirements laid down by us in our solicitation of this proposal. Also, independence, objectivity, replication, and credibility must be achieved by bringing in at an early stage a number of independent consultants to: (a) carry out their own studies on identical data; (b) confirm the uniformity of the quality of data used for each study; and (c) provide a completely open forum for the examination of this information by others who may wish to carry out their own investigations with complete confidence that the data have not been improperly tampered with or selected.

I urge support of the Oak Ridge National Laboratory proposal not because it is the only possible approach, but because it was the approach that we decided to solicit over a year ago and it is thus "ready to go" for a reasonable sum (less than 0.2% per year of the NRC research budget). I believe the team of scientists at ORNL who would manage this proposal for us are honest and capable scientists, and their integrity can be verified by the means that are mentioned in my above statements and in more detail in previous recommendations. They are ready to begin the work and are in close proximity to a vast amount of data for the Hanford population, which is securely maintained in the capable hands of Howard Fore at the Oak Ridge Computer Technology Center. This data must be properly protected. I believe that the ORNL group, under Drs. Ken Poggenberg and Cliff Patrick of the Health and Safety Research Division, can and will manage this program independent of the work being done by Oak Ridge's Associated Universities and others for the Department of Energy. If we had initiated this type of project over a year ago, as I urgently recommended then, we would not still be floundering around late and after the fact commenting only on rearrangements of the particular selected data as presented in the revised Mancuso-Stewart-Kneale paper,(1) which as I have indicated above contains many omissions, deficiencies, and absurdities of presentation and analysis. (I do not believe that the negative views of others on the NRC staff in regard to initiation of this project stem from any real knowledge by them of the data itself, nor from any real experience of any of them with any kind of radioepidemiological investigation. I have had first-hand knowledge of much of the data recorded for the health and mortality study, from my experience in the atomic energy program, as well as from 8 years as a co-investigator on the Mancuso study itself. I believe that we can assist the ORNL staff in obtaining the cooperation of those possessing and knowing the data.)

In addition to the recommendation for a strict reexamination of the Hanford mortality experience, I have also made several broader recommendations regarding a health effects research program for NRC since coming back to the Government 2-½ years ago. I shall briefly summarize these additional recommendations below, since they have also not been implemented.

2. The NRC should immediately initiate plans for a long-term prospective followup study of all employees monitored for radiation exposure in licensed nuclear power plants. Again, here is an area where it seems to me NRC should have a prime research, administrative, and auditing responsibility. To date, our collection of radiation dose (and related population identification) records has been very limited and haphazard, and very little use can be made of this data as collected in its present form except to examine gross overall exposure trends in the industries. More complete collection of central records, managed by appropriate computer techniques and evaluated by a team of professionals comprising

the breadth of knowledge required, would enable us to provide optimum information for long-term auditing of NRC's regulatory program.

Although I have emphasized initiating a study with reactor licensees, since they are a more homogeneous industrial group and some of the data collection problems would be easier, I feel that after a few years of experience, followup studies should be organized to cover all licensee employees who are exposed to radiation (ultimately, on a national basis, including all states that could provide data from their programs). This may sound overly ambitious, but it would not be an inordinately expensive program compared to its value (and to expenditures on dosimetry already made) if it were properly conceived and managed by an appropriate team of health specialists and scientists cognizant with all aspects of the data and evaluations involved. It is also important that the employee followup studies be initiated now, to avoid the expense in later year attempting to reconstruct exposure, identification, and mortality data on a retrospective basis, as has been done for many millions of dollars in the AEC-ERDA Health and Mortality Study under Dr. Mancuso.

3. I have also recommended an independent project to carry out a complete reexamination of available epidemiological and biostatistical methods in order to arrive at recommended methodologies and required data banks, as accepted and supported by an advisory team composed of professionals of the highest quality and reputation. Although my primary duties in recent years have not included epidemiology, my recent and previous examinations of some of the activities in this field have indicated to me that use of epidemiologic methods in health research is still in a relatively confused state. This includes the collection of essential health and mortality statistics on a national basis, and is not only related to NRC's inadequacies in this area alone. The lack of complete rational and standard methods for assessing health effects of environmental agents, food additives, and drugs on a national population basis has indirectly resulted in adverse effects on all of us personally as well as on the nation as a whole. I recommend high priority on a study of this kind to at least establish guidelines and methods for radio-epidemiologic studies pertinent to the evaluation and further development of NRC's radiation protection standards.

4. I recommend that in general the NRC should bring in some highly competent, reputable, and broadly trained health professionals and health scientists at various levels of management (including the Commission) as well as staff. NRC competence in the research and assessment of health effects and risks that might be produced by radiation should equal its competence in the fields of nuclear engineering, physics, and law. My colleagues have heard me ask myself, again and again during the past year, "Now that this agency is almost three years old, why are we still playing a major league ballgame with a third string high school team?" I am aware

from my earlier experience in the Atomic Energy Commission, as well as from following the regulatory program over the years, of the excellence in reactor safety evaluation and review as carried out generally with an eminent Advisory Committee on Reactor Safeguards (ACRS), in addition to very competent NRC regulatory staff members. Through this review process, I believe this agency has gained an outstanding ability and reputation for overseeing safety in the design, construction, and operation of nuclear reactors, as well as some of the types of facilities. However, although much due attention has been given to reactor operations and the prevention of malfunctions, and radioactivity releases, I do believe that some of the current need to specify additional design considerations to reduce employee occupational exposures to as low as reasonably achievable levels would not be as acutely overdue if reactor development had much earlier incorporated a greater participation of health scientists and health physicists.

It has seemed clear to me for some time that, since we are now an independent regulatory agency, our health research program (including epidemiology) should not ride on the coat-tails of the Department of Energy. At my level I am probably not aware of, nor have I been informed of, all the reasons that my proposals have not been implemented. The only answer that I can arrive at to explain the inadequacy of the scope, organization, and level of NRC's health science and health followup programs is that the management of this agency was born out of the professional nuclear engineering, physics, and legal disciplines inherited from the Atomic Energy Commission, and thus neither these professionals (nor Congress) have recognized the imbalance of our NRC regulatory program in regard to responsibilities for understanding health effects of radiation and following the health status of licensee employees exposed to radiation. In my opinion, the agency, as so constructed professionally, cannot adequately realize the appropriate efforts required to deal with this subject area. We are still fighting fires with staff members at the lowest level who (although good, competent scientists in certain areas) have had little or no experience, and no creditable reputations, in the health sciences, while the Department of Energy is enlisting some of the top scientists in the country in their efforts. Should the Department of Energy, with promotional responsibilities in regard to energy, be more interested in radiation health effects than we? The major role of our Advisory Committee on Reactor Safeguards may be contrasted with the complete absence of a top-level group that can objectively evaluate radiation exposure standards, risk estimation methods, and research and other programmatic requirements in the area of health. The Nuclear Regulatory Commission, an agency of 2,700 people, does not even have its own Medical Director or occupational health group to care for its employees, while it (properly) writes stringent regulations on how its licensees are to reduce even its smallest risks as low as reasonably achievable (ALARA). (I still have not had any response to my inquiry regarding an entry medical examination. It seems that we had a better program at AEC back in 1960.)

I want to make it very clear that my opinions as expressed in this memo haven't anything to do with personal job dissatisfaction, or dissatisfaction with things that NRC is doing. I believe that existing NRC programs are important, and I am happy with my job in the Occupational Health Standards Branch and with the important radiation protection guidance we are developing for the licensing programs. My supervisor and co-workers are among the Government's finest. I also have no specific problem with the individual qualifications and attitudes of other management officials. My frustrations rest with what NRC is not doing, or not doing adequately. I do not believe an inordinate amount of additional funding and staffing would be required to alleviate these deficiencies.

Since, as you can see from my above remarks, I feel very strongly about the importance of this matter to this nation and to the health and welfare of all its citizens, I am planning in the near future to make my views known outside of OSD, and to other cognizant legislative and administrative officials. I want it to be clear that these are my own personal views and do not necessarily represent in any way official Branch or agency opinion, or an attempt by me to represent anyone but myself. I am writing this only under the primary obligation that I feel any Government employee in a democracy has, to voice his individual views when he feels that they are in the national interest.

Mr. WALGREN. Mr. Carter?

Mr. CARTER. Thank you, Mr. Chairman.

What were the circumstances of your leaving Dr. Mancuso?

Dr. BRODSKY. That is a good question. I enjoyed 8 years with him. I am very grateful for it and for his friendship.

As some people have mentioned here, there were some selfish reasons involved. When one becomes a professor at the university and does not publish anything for 8 years, what happens to him?

I had a family to support, right? Dr. Mancuso was very helpful in helping me support my family, because he took me under his wing as a full-time coinvestigator the first year of his project, just when the other project of Dr. Wald's was ending I was initially on a year-to-year basis; I gave up a permanent job here in the Government to try to find out what the world was about, and Dr. Mancuso took me under his wing.

But, when I got my doctoral degree—thanks to Dr. Mancuso, who is a great gentleman—Dr. Mancuso was the one who originated the letter in 1966 that got me my tenured associate professorship. I do not forget that.

When I became a tenured associate professor of health physics, I wanted to do some health physics research, too. I had a lot of other research interests. I then worked only half-time with Dr. Mancuso. I was not counting on Dr. Mancuso's project along for my entire career, as you can see from my résumés.

Today we can see the vagaries of these epidemiological studies and what you can get into. It is a dangerous business, believe me. I am here at a dangerous time, too.

So I left the project in 1972, about 1 year after I gave up my tenured professorship at the University of Pittsburgh. In 1971 I received an offer to work with Dr. Carl Kaplan at Mercy Hospital, Pittsburgh, treating cancer patients. It was interesting to help him set up his new equipment, a new cobalt teletherapy unit and a linear accelerator. I had the advantage of working with Dr. Kaplan, and teaching biostatistics and epidemiology, and health physics, at Duquesne University.

So these are the reasons, selfish reasons. I would have liked to continue with the study—in fact, I did continue with the study for 1 year after leaving the University of Pittsburgh, due to the graciousness of Dr. Mancuso, who must have felt I was still useful to some degree. He continued me as a consultant until 1972. During 1971-72, I helped complete our first publication and presented my own methods and findings at the Health Physics Society symposium of 1971. The records show I still worked on the project until 1972. But my poor boss, Dr. Carl Kaplan, had those sick patients. He wanted me there by his side at Mercy Hospital to help him with them, and you cannot blame him. That is why I left Dr. Mancuso's project.

Mr. CARTER. There is one little error that you made in reference to death. Up to the age, up to 14, I believe you know, the leading cause of death from disease is cancer.

Dr. BRODSKY. Those people were not included in this study.

Mr. CARTER. Not only older people but among all the young people in our country the leading cause of death from disease is cancer. You are very intelligent, loquacious, and articulate.

Would Dr. Sanders agree with your testimony?

Dr. Brodsky. Dr. Sanders is probably so independent that he would not agree with anybody. He has his own set of testimony. I think you may note that it is in publication, his findings, where he did, at least partially, a longitudinal study. One of his tables which is in a paper to be published finds essentially no difference in mortality between the Hanford workers and his controls. He did not have access to all of the death certificate data as did Dr. Mancuso.

Mr. Carter. When have you been in touch with NRC? Have you talked with them recently?

Dr. Brodsky. Surely I have talked to them recently.

Mr. Carter. About your testimony?

Dr. Brodsky. About this testimony?

Mr. Carter. Yes.

Dr. Brodsky. No.

Mr. Carter. They were not reluctant about letting you come here?

Dr. Brodsky. I do not know what they thought in their hearts, but they did not try to dissuade me.

Mr. Carter. Were they not just a little bit—did they not urge you a little bit to come on?

Dr. Brodsky. Urge me to come out? Not whatsoever. Not one bit.

Mr. Carter. Thank you.

Would you say that Mancuso, et al., have widely publicized their findings, or has it been done by the insistence of the Department of Energy in terminating their project?

Dr. Brodsky. The Department of Energy made a big mistake, did they not?

Mr. Carter. I feel that they did. Really, it was not publicized greatly, not until this happened, and then all of it came up.

Dr. Brodsky. Ironic, is it not?

Mr. Carter. Yes, sir.

Let us go down to another thing that I wanted to ask you, since you are a biophysicist. What is the effect of ionizing radiation? Do low doses cause cancer?

Dr. Brodsky. It can. The question should be stated can it, because it is a probabilistic phenomenon and I can expound in 10 hours as to why it is. It is a scientific fact.

Mr. Carter. I do not doubt it a bit. Do you think there is any increased risk from working in the plant in Hanford than working in Tucson, Ariz.?

Dr. Brodsky. I think there would be an increased danger of somebody working in Hanford getting more exposure than somebody working in the same environment getting less.

Mr. Carter. Any more danger of their getting cancer?

Dr. Brodsky. There is a relationship between exposure and cancer, yes. It is a probabilistic one.

Mr. Carter. Let us get right down into it.

Dr. Brodsky. Probabilistic.

Mr. Carter. So would you say that for workers at Hanford, there is an increased risk of dying from cancer?

Dr. Brodsky. Not more than any other plant in the world, perhaps.

Mr. CARTER. Not more than any other nuclear plant?

Dr. BRODSKY. I chose this field. I was lucky. I have received a total dose 2,000 centirads—20,000 millirads—most more than 20 years ago, and I feel fine.

Mr. CARTER. Maybe it is the cause of your energetic testimony.

Dr. BRODSKY. I have had three healthy children, 25, 21, 20, and they are all well today.

Mr. CARTER. I wish I could say the same, my friend.

Dr. BRODSKY. There is still a probability that I and my children may still be affected by that exposure, but I believe the chances of an effect are small.

Mr. CARTER. How much exposure did you say you had had?

Dr. BRODSKY. On the order of 20,000 millirem, total. Mostly in the early 1950's.

Mr. CARTER. 20,000 millirem is 20 rem. What is a rem?

Dr. BRODSKY. A rem is a unit of radiation dose describing a number that has been corrected so that you get, supposedly, an equivalent effect to 20 roentgens of *x* or gamma exposure.

Mr. CARTER. One, not twenty. One roentgen per rem.

Dr. BRODSKY. If you assume a quality factor of one.

Mr. CARTER. What is the difference between a rem and a rad?

Dr. BRODSKY. A rad is the unit of absorbed dose; 100 ergs of per gram of anything is a rad.

Mr. CARTER. That is where it gets to you, that radioactive absorbed dose. You do not think there is any danger working in Hanford?

Dr. BRODSKY. Danger is a relative thing that is probabilistic. There are small dangers, and minute dangers, but, by God, if you are going to sweat about working at Hanford at the occupational exposure rates that I have seen in the records there, then you had better break out in a sweat every time you get into your car. That is all I am going to say right now.

I do not want to overestimate and I do not want to underestimate risk. I want to come up with the truth.

Mr. CARTER. I want you to come up with the truth, too. Please prove to me, that it is not dangerous.

Dr. BRODSKY. I did not say that it was not dangerous. Danger is relative. Danger has a probability proportional to the dose. It is a curvilinear function of a certain kind.

Mr. CARTER. Thank you, Mr. Chairman.

Mr. WALGREN. You are not suggesting that there is any radiation danger in getting in your car, you are suggesting that there is a risk of harm?

Dr. BRODSKY. The risk of getting 45,000 people a year killed in automobiles. I do not want to get too wordy about this.

Mr. WALGREN. One thing I wanted to just explore very briefly, when we talk about risk of harm, for example, from working in Hanford as opposed to getting in your car, it is not that it is just a risk. It is that it is going to happen, it may not happen to you, but it is going to happen to somebody. In that sense, it is not a risk.

It is a risk to you individually, but it is not a risk to the population as a whole. It is a certainty to the population as a whole.

Dr. **Brodsky**. In radiation exposure there is no such thing as certainty. If you have very little exposure, you do not have a large enough population to observe the effects. That is why some studies have not shown the effects; they have not been large enough.

Mr. **Walgren**. This is what bothers me so much. I saw on television the other morning the workers and they were happy as larks. They were smiling and laughing and believing that it did not apply to them.

I am assuming that there may be an increased cancer rate among a population with a given exposure. Those poor souls were like the soldiers in Vietnam. They were not the ones that were going to get it. Someone else would get it, but they were not the ones that it was going to happen to.

Dr. **Brodsky**. You have to take your chances.

Mr. **Walgren**. My only point is this, is that someone is going to get it. It may not be me, it may not be Dr. Carter, but it may be someone nearby.

Mr. **Carter**. Mr. Chairman, if you would excuse me for just a moment?

Just a few years ago we had a Health, Education, and Welfare appropriation bill and that was very much on point. At that time, because of this research and so on, at that time I made the statement that approximately one out of every four members there, or members of their family if they wanted to go that far, would have cancer within that year.

The veto was overridden and we got the funds for cancer.

Shortly after that, Vice President Rockefeller's wife came down with cancer. A little after that, President Ford's wife came down with cancer.

You can look at the record and see that that is true, sir.

Now, it is true that we have 50,000 people a year—hardly that, I believe, we have slowed it down some. You know, we lose 350,000 people every year from cancer. No less than that.

Thank you, Mr. Chairman.

Dr. **Brodsky**. That is why I have worked to minimize radiation exposure.

Mr. **Walgren**. My point is simply that when we say that there is an increased risk of cancer among a certain population, we really mean that somebody in that population is going to get cancer. It may not be me, it may not be you, but there will be 4, 8, 16, whatever the number is, increased incidences of cancer, and it bothers me a lot when people say oh, it is just a risk.

For example, we do not talk about the Vietnam war and say well, it is just a risk of death. We say, war causes death. And what we are talking about is that radiation causes cancer.

The soldier beside me may be the one who will get the bullet through the head, but that should not make me feel any better.

Dr. **Brodsky**. We must be careful. We must know what these risks are, because Dr. Mancuso can get up here and talk for hours about all the health risks in chemical industry. We do not want to deprive a worker of a job where he may have a chance of 1 in 10,000 of getting cancer, in a nuclear industry that we then close down, and send him to an industry where he might have 1 chance in 50, or 1 in 10 of getting cancer. So you had better be careful in understanding risk and what all the risks are. You can ask Dr. Mancuso about risk in some of the chemical industries; he taught me a lot about that.

Mr. Walgren. And by that, when you use the word "risk," you mean you had better be careful in understanding how many more deaths you are going to cause.

Dr. Brodsky. You had better look at all your possibilities, you and Congress; you have to deal with the entire Nation.

Mr. Walgren. Without objection, I would like to mark the record at this point for Dr. Mancuso or any related investigator to insert an evaluation of your critique and perhaps the record of the hearing can serve that function.

I would really like to thank you for your testimony. You underscore what I think is the real deep conviction of a number of members of this committee, and many of the public, that we are really concerned about the independence of these studies. I am sure that you would not be here asking that the Congress to set up an independent national group of eminent scientists to evaluate this research if you were comfortable with the evaluation that the Department of Energy may give that research.

Dr. Brodsky. I am not really entirely comfortable. I do have some further recommendations if you want to hear them later.

Mr. Carter. There were some 2,235 soldiers who wore film badges and we have been able to get about 447 so far by name. For a long time we could not get any of them, but we did. We are getting them now.

Of those 447 at Smoky, 8 had or have died of leukemia. Do you figure this statistically significant?

Dr. Brodsky. From what I heard at the meeting, I think so. As a scientist, I would like to look at the data myself, and make an independent investigation before answering such a question definitively.

Mr. Carter. You are a statistician, you are a biophysicist, you are an epidemiologist and all of these things. Surely you can tell me if that finding is statistically significant. I would like to know.

Dr. Brodsky. Could you repeat that?

Mr. Carter. Of the 2,235, 8 have leukemia, or have died of leukemia. Is this statistically significant?

Dr. Brodsky. I guess it may be. I do not have enough data to tell. As you know, sir, in statistical significance testing you have to know how many are expected.

Mr. Carter. I will give you that.

The age group here was from 40 to 44 and the expected incidence of leukemia is 4.1 per 100,000. Should I give you and other figures?

Dr. Brodsky. The same age group?

Mr. Carter. That is it.

Dr. Brodsky. This is awfully suspicious. I do not know what the doses are.

Mr. Carter. It sounds awfully suspicious, and it is statistically significant.

Dr. Brodsky. Statistical significance is something we must explain to the public. Before one decides statistical significance one has to choose out of the air an alpha level at which you want to decide a difference is statistically significant. That is a variable;

alpha is the probability you decided to accept that you will be wrong in concluding a difference is significant.

Mr. CARTER. Is meaningful. You cannot say it is absolutely possible, but it is likely?

Dr. BRODSKY. I can only give an answer by feel at the moment.

Mr. CARTER. Your answer is?

Dr. BRODSKY. I really believe——

Mr. CARTER. Please give me your answer.

Dr. BRODSKY. This is my feeling; I have not done a calculation. From what I have heard, there is a probability that some of these leukemias were due to radiation. I have not calculated the effects from Smoky. It is probably more likely than not at this point.

Mr. CARTER. More likely than not. That is a good answer, and I want to thank you.

Dr. BRODSKY. It is more likely than not that Dr. Mancuso will find some radiation induced cancers if he continues to look.

Mr. CARTER. I want to tell you, I think every man and woman of your training has answered the same way, with reference to my question about leukemia cases among soldiers at the 1957 atomic blast Smoky.

Dr. BRODSKY. Thank you.

Mr. CARTER. Thank you, sir.

Mr. WALGREN. In closing, I would like to underscore the validity of your second recommendation, which is that each agency should maintain permanent record systems of exposure and should also maintain appropriate data to carry out annual health evaluations of anyone exposed, and I really believe that that does two things.

No. 1, it underscores the question about the attitude of the people who have not maintained records, or even made attempts to be able to carry out annual health evaluations. Because of that frame of mind we find ourselves in a position where we have hundreds of thousands of Americans that were exposed but not followed whatsoever.

As a personal opinion, I can only describe the frame of mind which neglected to follow those individuals in this exposure as downright negligent. That also goes to the point of the necessity of independence in terms of conducting these studies and in evaluating them, because if we have the same frame of mind conducting these studies and drawing the conclusions from the statistics, the public will never be able to have confidence in the results.

I appreciate your testimony very much.

We will recess at this point, and carry over the testimony of Drs. Bross and Upton until Tuesday, February 14. We thank you for your patience.

The subcommittee is recessed.

[Thereupon, at 5:50 p.m. the subcommittee adjourned to reconvene Tuesday, February 14, 1978.]

EFFECT OF RADIATION ON HUMAN HEALTH

Health Effects of Ionizing Radiation

TUESDAY, FEBRUARY 14, 1978

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON HEALTH AND THE ENVIRONMENT,
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10:20 a.m., in room 2167, Rayburn House Office Building, Hon. Paul G. Rogers, chairman, presiding.

Mr. ROGERS. The subcommittee will come to order, please.

Today, the subcommittee will continue its oversight hearings on the health effects of low-level ionizing radiation.

Our first witness this morning will be Dr. Irwin Bross, the director of biostatistics, Roswell Park Memorial Institute, Buffalo, N.Y.

Dr. Bross, welcome to the committee. Your statement will be made a part of the record in full at this point and you may proceed as you desire.

STATEMENT OF IRWIN D. J. BROSS, PH. D., DIRECTOR OF BIOSTATISTICS, ROSWELL PARK MEMORIAL INSTITUTE

Dr. BROSS. Thank you, Mr. Chairman. I would make some changes in the written statement when it is somewhat outdated by events, but I will not attempt to correct it at this point. However, I will correct it in writing. I also would like to make an official disclaimer which I make when I speak in public. Although my salary is paid by the New York State Health Department and I have been director of biostatistics at Roswell Park for more than 18 years, I am speaking as an individual and not for the health department, and I am here at my own expense and on my own time.

Mr. ROGERS. Yes; and we appreciate your being here.

Dr. BROSS. There are two principal topics that I have been asked to discuss, and I would like to briefly outline my position on these topics. The first question is, what is the current situation with respect to our scientific knowledge of the human hazards of low-level ionizing radiation?

What I will have to say is largely based on the presentation that I prepared for an open meeting of the Nuclear Regulatory Commission which is now scheduled for April 7, 1978. However, this is an hour-long presentation with a lot of slides, so I will only try to present highlights here. I will not try to present that material.

Mr. ROGERS. That would be helpful.

Dr. Bross. However, I would like, just to be sure that the documentation is along, to note that I have previously submitted the first draft of this testimony, entitled "Hazards to Persons Exposed to Ionizing Radiation (And to Their Children) From Dosages Currently Permitted by the Nuclear Regulatory Commission." And that I have submitted, and I think that should be part of my testimony.

Mr. Rogers. Without objection, it will be received for the record. [See p. 913.]

Dr. Bross. The second question is what is the present and past situation with respect to incentives and disincentives for research on the hazards of low-level ionizing radiation and here there is a sordid story extending back to the furor over fallout from weapons testing. It is a story where researchers were rewarded for not finding any hazards and punished if they failed to support the official AEC line that these low levels of radiation are harmless.

Although in the past year or two, the general public has finally heard the truth about the hazards of low level radiation, for many years the publication of positive findings was difficult or impossible in many prominent technical journals, including "Science," and even today, our research and Dr. Mancuso's have not been funded because our findings were not what the Federal agencies and their peer review panels wanted to hear.

With your permission, I would insert a second body of documentation that I sent to Dr. Zimmerman. It is listed there as previously submitted 1—and previously submitted 2. Previously submitted 1 includes the documentation and exhibits sent to Senator Adlai Stevenson's committee—it is not really his committee; he was chairing the committee—on Commerce, Science, and Transportation and is entitled "A Report on Actions of Two Federal Agencies, ERDA and NCI, in Terminating Funding for Two Major Studies of the Health Hazards Produced by Low-Levels of Ionizing Radiation."

That material has a number of supporting documents attached to that.

Mr. Rogers. Without objection, so ordered. [See p. 559.]

Dr. Bross. Turning now to an update of our findings in the terminal year of our NCI grant, let me begin with a brief recap of what I reported to a Senate subcommittee on June 17, 1977. At that time, I pointed out that the crux of the public health problem is exposure to dosages in what can be called the 1 rad range. This range starts at 100 millirads, or one-tenth of a rad, and extends to 10 rads.

Doctors generally talk about the rads as a measure of amount of radiation that is absorbed while the health physicists prefer to speak about rems, but the two are related.

The important point about this particular range, the 1 rad range, is that the vast majority of all exposures occur in this range. This is true whether we are talking about diagnostic X-rays delivered to patients or nuclear radiation delivered to workers—or I might even add now, in view of some material I received from NRC, nuclear exposures involved in nuclear medicine. This is why we are so interested in the health hazards in the 1 rad range.

Studying the hazards to health in this range is difficult and it takes a massive data base of carefully collected scientific and medical reports to get reliable findings on human beings who are exposed in this range. As you have already heard, Mancuso, Stewart, and Kneale studied more than 30,000 workers at the Hanford reprocessing plant and the deaths of these individuals over a period of more than 20 years.

In our tristate data, the population base, so far as leukemia is concerned, is about 13 million persons over a 3-year period. These are the first two scientific studies with this kind of data base on human beings who were actually exposed to ionizing radiation in the 1 rad range.

The previous estimates were obtained by extrapolation from data on humans exposed to relatively high dosage—that is in the centirad range, probably—or by extrapolation from animals to man. So these older estimates are educated guesses, perhaps the best that could be done under the circumstances, but they are now superseded by direct estimates.

The general conclusion that I reported to the Senate committee is, in simplest terms: The older estimates of hazard have grossly underestimated the actual risks, that is, those calculated from what actually has happened to human beings exposed to ionizing radiation in the 1 rad range.

From a public health standpoint, this was very bad news. It was also very bad news to those whose livelihood depends on radiation technology and who have long been accustomed to exposing paients or workers to so-called harmless dosages in the 1 rad range and who are now faced with the task of cleaning up their act.

Exposures to radiation in the 1 rad range are hazardous to the health and I think that in the past year the general public and its representatives have come to recognize this fact. But the radiation protection community and those with a stake in radiation technology do not seem to realize that, after a generation, the cat is finally out of the bag and it will not go back into the bag.

These people are so far out of touch with scientific and political realities that they are currently lobbying to increase the permissible dosage levels. Unfortunately, as you heard, they influence the machinery that is supposed to fund the research and set the permissible exposures that will protect the public health.

The basic conclusion that the health hazards in the 1 rad range are far worse than we originally thought has been strongly reinforced by the more recent research of Mancuso, Stewart, and Kneale, and by the research carried out by my team, which includes Mr. Natarajan, Dr. Ball, and Dr. Bertell. I might, for purposes of identification if it comes up later, note that Dr. Ball is better known as Sister St. Augustine and Dr. Bertell as Sister Rosalie. Those are their religious names.

One of our major new findings is the quantitation of just how bad the hazards, particularly the risks of leukemia are, and one way to express this is what is called the doubling dose. Roughly speaking, this is the amount of radiation that will double a person's chance of getting leukemia or other disease. I would correct the statements that follow here, because I think that they could be misunderstood. One study deals with multiple myeloma and one with leukemia, so I would correct the statement there slightly. It is not actually false, but it could be misleading. Therefore, I would just say our estimates indicate that the doubling dose for leukemia is probably between 3 and 5 rads.

Now, what does this mean? First, consider what it means to nuclear workers where the level of radiation exposure currently permitted by the Nuclear Regulatory Commission each year is 5 rems. It means that the NRC considers it acceptable to expose a worker to a dose which would double his risk of leukemia year after year, if he were exposed to the maximum.

In theory, though probably not in practice, if a worker received 5 rads a year for 10 years this would increase his risk by 2^{10} or a thousandfold. I am not strongly urging that figure. There is a lot of argument in the scientific community about whether you should do it this way or not. I do not think you have to have a thousandfold increase; I think that if you doubled the risk of leukemia, that is a serious problem which you would want to avoid.

I will try to make this point to the NRC, of course, as forcefully as I can. Unfortunately, I do not see much indication that the NRC is willing to face up to its public health responsibilities. At that point, I inserted appendix A-1, which is a letter I wrote to Michael Parsont of the NRC on January 18, 1978.

There have been some recent developments in this respect. They are on both sides, both ways. They are all from the NRC, but one seems to be taking a much more sensible attitude and the other is taking a very hard-nosed attitude. Since they are both coming from the same agency, I believe the sensible attitude—I hope, certainly—that the sensible attitude is the one that prevails. I would like to add two new letters to appendix A-1.

What does this finding mean for medical X-rays? Here an annual exposure of 5 rads is not necessarily theoretical. Dr. C. D. Haagenssen of Columbia Presbyterian in New York City recently told me that he sees patients who report that they have had 10 or 15 mammograms although they are still in the thirties and forties, and some women seem to be getting a mammogram a month if they are very nervous. Now, the exposure is somewhere between 1 and 5 rads per mammogram.

Also, patients with stomach diseases undergo an annual GI series with exposures in this range. I have recently written a letter to the VA on this point on behalf of a veteran whose condition—I would slightly change my original statement since his condition is not strictly a stomach disease—was service connected. He had an annual GI series and he now has leukemia and he is asking for service connection. I would support his request.

So there no longer is, as far as I am concerned, any scientific question that the radiologists and other physicians who still claim that these low levels of radiation are harmless and who use them indiscriminately, promiscuously, are killing some of their patients. I don't believe it absolves these professionals to say that they are hurting their patients with the best of intentions. In my view, it is malpractice to deliver any X-rays unless there is a good and sufficient medical reason to do so, something which nowadays is often not the case.

I might insert parenthetically that the Bureau of Radiological Health estimate is between 30 and 40 percent of the X-rays, medical and dental X-rays, delivered currently are unnecessary.

Special precautions should be taken with patients under heavy radiological surveillance. The medical profession ought to act voluntarily to stop this malpractice but, as a thoughtful radiologist indicates in an article which I have appended and which I have added to the record, they will probably need Federal legislation to achieve this goal.

I think that this is a good statement of an intelligent position on the part of radiologists, but it is difficult to maintain that position in competitive practice. Just so that there will not be any confusion on this, I am not a physician; I am a biostatistician.

On environmental carcinogens, and there is no question that low-level ionizing radiation is an environmental carcinogen, we have a crazy quilt pattern of protection. On one hand, grandfather clauses will protect carcinogens such as radiation or cigarette tars. On the other hand, what I would call the primacy principle, is in effect in agencies such as the FDA.

This primacy principle says that with potentially hazardous technology, the benefit of the doubt must go to the public and not to the technology, and I think the Delaney amendment is one implementation of this principle. I find it ridiculous that one agency will ban a carcinogen if it produces cancer in a few animals and another agency will permit carcinogens at levels known to produce cancer in man.

I also find it ridiculous that some dosage levels are set by taking the minimum dose which produces a detectable biological effect in animals and permitting only 1 percent of this dosage, while the NRC with the doubling dose in humans in the range currently permitted has done everything it could to stall off a reduction in permissible levels to 10 percent of this dose, that is, to half a rad.

Responsibility for protecting the public against radiation hazards is now scattered through at least half a dozen Federal agencies, none of which, I believe, are doing very much that is effective, and all of which can evade responsibility by pointing to someone else. I think that responsibility and authority should be fixed in one agency and it should have the funds and the scientific competence to do a good job of protecting the public, although this would take legislation.

Mr. Minogue of the NRC sent me a document prepared for congressional use, by Senator Pastore, I believe, which makes this point very well.

We now have a number of interesting findings which I can only mention in passing. The long and involved process which starts with exposure to ionizing radiation or some other carcinogen and ultimately leads to cancer or other disease is one which we are beginning to understand. We do not know all the steps, but our recent research, and that of others, has made it clearer how the process starts. We have a good idea of what the first event is, and we know something about the evolutionary process that leads to cancer. In other words, in this sense, we now know the cause of most human cancer, and we also have a good idea of how to go about controlling cancer by primary prevention.

The first event occurs when radiation puts an additional breakpoint into the structure of the DNA in human genetic material. This misinformation in the instructions for making enzymes and regulating the complex human host defense systems can lead to failure of the feedback system that controls white cell production, hence leukemia.

For this to happen, however, the misinformation in the original damaged cell must be duplicated until there is a large enough population of defective cells to produce clinical symptoms. This is the reason for the latent period. In the end, I believe we will learn that cancer and other chronic diseases are often different expressions of the damage to human DNA—of genetic damage—that is produced by various environmental hazards. Radiation is a very important hazard, but it is not the only one.

Now, Mr. Chairman, this completes my testimony on the first point, that is to say, on the hazards of low-level ion radiation and if the committee wishes, I could respond to questions on that and then go to questions on the second, the incentives and disincentives.

Mr. ROGERS. I think that if you would complete your statement, then we will question you on it.

Dr. BROSS. All right.

Let me now turn briefly to the second topic, the disincentives for research with positive findings on low-level radiation hazards. There are three main disincentives. The first is suppression of the findings by blocking publication or presentation at meetings. The second is attacking the reports and their authors by the professional version of what is ordinarily called scurrilous gossip. The third disincentive is to cut off the funding of the research. All three disincentives use peer review as the instrument. By peer review, I mean only the small, closed-in groups that control much of the decisionmaking in the sciences. There are a lot of varieties of peer review.

The other side of the coin are the incentives given for negative findings. These include publication, appointment to prestigious committees, increased funding and so forth. This structure of incentives and disincentives is one of the main reasons why the public has received so little of value for the large sum of money spent on radiation research.

We, in a sense, are rewarding expertise in not finding anything positive, and so we get that kind of work.

In my own case, the disincentives were only partially effective. For instance, our findings were first submitted to Science where the peer review process was personally managed by Dr. Philip Abelson, the editor of Science. The article, like the attached editorial which I am enclosing in my testimony, an editorial I wrote for Science, was rejected, but this rejection failed to block publication because the material was subsequently published by the Journal of the American Medical Association about a year later. If anything, it had added impact.

The attacks on our work also backfired. On the MacNeil/Lehrer report of November 25, 1977, a long-time executive of the NCRP, Dr. Lauriston Taylor, asserted that our findings had been reviewed and rejected by unidentified top experts. When I wrote him for documentation—I have an enclosure on that—I received a lame response—also submitted—admitting essentially that his statement was based on nothing more substantial than hearsay, or, in everyday language, backfence gossip.

When a Jack Anderson column reported our fate and that of others who had positive findings—a copy of the column is submitted—and Dr. Bernard Cohen wrote a letter in which he lists a series of agencies which he claims have reviewed and rejected our work.

Dr. Cohen has been associated with Atomic Industrial Forum, which is the industry lobby, and his libelous statement is simply a lie. None of the agencies have reviewed our work, in a formal sense, nor rejected it formally. In fact, the work is coming up for its first formal review when I will present it at the Nuclear Regulatory Commission hearing on April 7, which is a meeting held specifically for this purpose.

Attacks by gossip and innuendo on scientists who come up with positive findings have hurt their careers and there is really no defense to this kind of thing. And I would like to add one more example of this that happened in my Friday testimony, because Dr. Victor Bond, speaking for the National Academy of Sciences stated at the meeting on February 10 on this topic, you know, the same thing. I was reporting our doubling dose findings, he said this work has been reviewed and rejected. It has not even been seen.

Mr. ROGERS. Who was it who said that?

Mr. BROSS. Dr. Victor Bond. He may have been confused by something, but what he said is wrong. It is a pretty damaging statement to make, this, for a scientist.

The third form of disincentive, cutting off research funds, was successfully used against our radiation research. It will not be funded after August 1978. This has already hurt us because half of my staff has left to take more permanent positions, with my blessing, and realizing that this would happen I made a hard decision last May to concentrate on getting as much research done as possible instead of putting the time and energy into desperation grantsmanship.

The NCI gave me no alternative, I felt, to going back to the same peer review group that had already turned us down—I will say something about that in a moment. As a statistician, I do not like to buck these odds and as a scientist, I must admit I would rather do something I enjoy, research, than something I do not enjoy, grantsmanship.

The trouble with peer review system—it is not necessarily inherent, but it is basically a flaw in the system as it stands now—is that it is a two-track system. There is a double standard. There is an inside track and there is an outside track. It is very hard to get through it if you are on the outside track and it is quite different if you are on the inside track.

What I had to do was to go to a panel consisting almost entirely of M.D.'s, not even practitioners, mostly administrative types, deans and so forth, to ask for support of studies on doctor-caused cancer—or, more politely—iatrogenic cancer. This is something like asking the hair dye companies to support our research on the excess cancer among cosmetologists.

I might note that at the site visit itself, the attack was led by an angry radiologist from M. D. Anderson, but I have submitted full documentation of the conflict of interest in this peer review and so I will not go into that in great detail. I will simply say that the best refutation of the subsequent critique that came out in the so-called pink sheet is this fact, that the work that was most bitterly criticized, that was said to be so terrible, if you read the pink sheet, was the same material that was subsequently published in JAMA, although neither they nor I knew this was going to happen. I would not, I think, have happened if there had been any validity to the criticisms.

I would just like to add one further point which just occurred, and I will submit this as a further document to the committee, that there is another kind of peer review which is—some papers are selected for the 1978 "Yearbook of Cancer"—not very many, out of all of the papers that are published. This paper was selected.

In summary, the big science Federal agencies such as the AEC, their industrial constituencies and their allies in the scientific and medical communities, have been, in my view, lying to the public about the hazards of low-level ionizing radiation for 25 years. To protect the lie from exposure by honest researchers, big science has used its control of the peer review mechanism to suppress, vilify, or cut off the funding of the little scientists who told the truth, or thought they were telling the truth.

And, as a direct consequence of this lie that low-level radiation is harmless, millions of Americans have been needlessly exposed to unnecessary and useless radiation that has produced, is producing, and will produce, tens of thousands of cases of leukemia and other serious diseases.

Servicemen have been marched through radiation from fallout as a public relations gimmick of the DOD and AEC to show just how harmless the fallout was. Millions of Americans have been treated by radiologists for very minor self-correcting conditions, such as acne or post-partum mastitis, where there is even some question as to whether it should be counted as pathology, and many have ended up with thyroid cancer, breast cancer and other disease.

More recently, a quarter of a million American women have been marched through the radiation fields used in the mass screening program of the American Cancer Society and will, in 15 to 20 years, I predict, they will become the victims of the worst iatrogenic breast cancer epidemic in medical history.

Despite the clear evidence on all sides that low-level ionizing radiation is not harmless and should not be used casually and promiscuously, big science has continued to lie to the public about these radiation hazards. I think that the Smoky episode and the other things that are coming out about exposures to the servicemen have alerted the public and created a situation favorable for action. I see an analogy between this and the situation with thalydimide, where it took this kind of thing to get the kind of legislative action that had been sort of sitting in the wings for a long time.

So I feel that, unless Congress passes legislation this year to deal with the clear and present dangers of low-level radiation, there may be little chance of effective preventive action in the forseeable future.

That is the end of my testimony.

[Testimony resumes on p. 1008.]

[Attachments to Dr. Bross' prepared statement follow:]

HAZARDS TO PERSONS EXPOSED TO IONIZING RADIATION (AND TO THEIR CHILDREN) FROM DOSAGES CURRENTLY PERMITTED BY THE NUCLEAR REGULATORY COMMISSION

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My intention at this hearing is to present the complex technical issues involved in the study of the hazards of low-level radiation in language that the general public can understand. We are using a format sometimes called an "Adversary Science", which will allow the public to hear and judge the arguments on both sides. The Nuclear Regulatory Commission doesn't care for the term "Adversary Science" because it might suggest hostility. However, the law has used adversary proceedings for centuries without this connotation and this is where the name comes from. Because this is one of the first hearings of this kind on a technological issue, we have a few guidelines or groundrules or precedents so I will start by suggesting one.

This guiding principle might be called the "Primacy Principle": When we are dealing with a public health issue involving possibly hazardous technology, the benefit of the doubt must go to the public and not to the technology. In the past regulatory agencies often operated on the reverse principle and this is why we now have so many environmental health problems.

The Primacy Principle allows us to deal with more specific issues such as the question of "burden of proof". In these complex issues it is unrealistic to expect that the hazards of a technology can be proved beyond a shadow of a doubt. There always will be some doubts. Applying the Primacy Principle we are led to the following practical corollary: The proponent of a hazard hypothesis has the burden of establishing a prima facie case for the hazard. Thereafter the burden of proof shifts to those who want to use a technology to show it is safe.

What I propose to do here is to establish a strong prima facie case that there are serious human health hazards from dosages of ionizing radiation in the range between 100 millirads and 10 rads. For brevity, I'll refer to this as the "one rad range". The current standards set by the Nuclear Regulatory Commission permit exposure up to 5 rem per year, that is exposure in the one rad range. I will argue that nuclear workers should not be exposed to known hazards and the 5 rems level should be reduced by a factor of at least 10.

I will base my case on factual evidence from a population base of 13,000,000 human beings. Some of these persons were exposed to ordinary diagnostic x-rays--to ionizing radiation that is nearly always in the one rad rad range and usually less than 5 rem--while others did not report radiation exposures. I am dealing with matters of fact, not matters of opinion. It is a matter of fact that persons exposed at these low levels of ionizing radiation showed increased risks of leukemia and other diseases. Sometimes the effect showed in the person exposed, in other data the effect shows up in the child of the person exposed. These facts establish a strong prima facie case that there are serious human health hazards in the one rad range.

In line with Primacy Principle, I don't claim--and don't have to claim--that the massive epidemiological and statistical evidence that I will summarize today will establish the risks beyond a shadow of a doubt and to everyone's satistfaction. A quarter of a learned that this cannot be done on any public health issue where large sums of money are involved. In those days I was working with Dr. Wynder on the health hazards of cigarette smoking and with the Cornell Automotive Crash Injury Research programs on highway accidents. We had solid factual evidence on risks in cigarettes-and-lung-cancer and for seat-belts-and-injury-prevention (although the evidence I have today is stronger in some ways.) However neither the Tobacco Industry nor Detroit would accept this evidence at that time. Interestingly enough both industrial groups have come around to our view of hazards but it took 15 or 20 years. It is evern more intersting that few if any of the scientists and physicians--including some at Harvard--who defended the original industry position has ever publically admitted that they were wrong in their criticisms.

What I want to stress is the grim cost to the public of the irrelevant and unnecessary controversies on public health issues that should have been settled by close attention to the facts. As a direct result in the delay in effective action that resulted from the protracted controversy, there have been hundreds of thousands of unnecessary deaths among smokers and on the highways, millions of avoidable episodes of disease and disability, and billions of dollars in medical costs and lowered earnings. The controversy over the hazards of low-level ionizing radiation that has gone on for over 20 years has had similarly adverse health effects for the public and in addition has produced genetic damage that will plague us for years to come.

My hope today is that this hearing can set a new pattern which will help us in the future to avoid the terrible human costs of the controversy and cover-up that has occurred with public health issues in the past. The Primacy Principle is essential. There is no factual evidence that I could produce today that would convince the nuclear industry, radiologists, or others with an enormous dollor stake in radiation technology that these low-levels pose a serious threat to human health. It would be equally impossible to convince the allies of the technologists in the academic or scientific or medical communities. However the decision on public health should be up to the public and not to the techologists. The Primacy Principle puts the public in the position of a grand jury that is hearing testimony on the hazards. The public can decide whether or not there is a prima facie case against the 5 rem level that is strong enough to bring this standard to trial. At the trial itself, it should be up to the defenders of the 5 rem level to make a case that it does not produce serious health hazards.

Let me make it crystal clear right from the start that we are dealing with a question of fact. We are not talking about whether there might be or could be or ought to be hazards in this range, we are talking about whether there are hazards in this range. I will present solid factual evidence that there are hazards in this range. Before it is all finished, I will show you the first dosage response curve ever constructed for the risks of non-lymphatic leukemia for men exposed in this range.

My opponent must take the position, contrary to mine, that there is no hazard and he has to present evidence which will support this claim. It is not enough for him to argue that there might be various faults or imperfections in the data, that there might be questions or doubts about the mathematical arguments, or that there are alternative interpretations of which would be somewhat different from ours. In this case, the benefit of the doubt should go to the public, according to the Primacy Principle. In past critiques, a number of technicalities have been raised that merely obscured the basic public health issue. I hope the debate today will deal with substantive issues. This is a yes or no question of fact. I'm arguing yes. My adversary, like it or not, has to argue no.

Now let me say a little about the present situation with respect to determining the hazards at the one rad level, where most of the exposures to nuclear radiation or diagnostic x-ray occur. In the past, estimates of the risk of leukemia from these low doses of ionizing radiation have been based primarily on linear extrapolation from data on persons or animals that were exposed to much higher doses of radiation. For example, the estimates in the famous BEIR report which has been the accepted standard reference for setting the permissible levels of ionizing radiation are based on this kind of extrapolation from dosages in the hundreds of rads or centirad range. However, in the past year or so, there has been a marked change in this situation. That's why I'm here. There are now estimates of the hazards of ionizing radiation in the one rad range that have been obtained directly from data on human beings who were actually exposed to ionizing radiation in this range.

What this means in terms of our knowledge of the situation in the one rad range is this: Before we were dependent upon what amounted to "educated guesses", rather than information on what actually happened in the one rad range. Now two separate, and independent bodies of data, on human beings exposed in the one rad range, have been analyzed in the past year or two. One is a study by Mancuso, Stewart and Kneale based on over 30,000 Hanford workers exposed to nuclear radiation in the one rad range. Our study is based on a Tri-State survey of a human population of 13 million who were exposed to diagnostic radiation in this range.

I am going to be talking mostly about our studies and I have mentioned the Mancuso study primarily for two reasons. First, our results agree with their finding that the extrapolative estimates have underestimated the human hazards of radiation in the one rad range. Second, their estimates are based on exposures to nuclear radiation and hence are more directly relevant to the Nuclear Regulatory Commission's setting of levels than ours (which are based on diagnostic radiation). Consequently, an important piece of information is that, despite the different kinds of radiation, there is a similarity between the findings of the two studies.

A great deal of fuss can be made about the differences between nuclear radiation and diagnostic radiation. This difference comes into the units of measurement. I'll be talking about "rads" because this is the natural language for talking about diagnostic radiation. "Rems" are commonly used for talking about nuclear radiation. However the two are supposed to be calibrated. While the calibration may not be perfect, it does not have to be perfect for our present purposes. The equivalence between rads and rems may be rough, but it is not very far off. It won't change any of the arguments that I will be making today. I am not going to present evidence from the Mancuso study. I merely want to cite it as collaborative evidence and to suggest that it be the basis for a second hearing on this topic.

Our research uses the data of the famous Tri-State Survey. This is a survey of cases of leukemia in the sample areas of New York, Maryland, and Minnesota that was carried out between 1959 and 1962. Using this survey data, we have previously reported that there are drastic increases in the risks of leukemia and other diseases in the children of mothers exposed during pregnancy to low doses of ionizing radiation, to mothers exposed prior to conception, and to fathers exposed prior to conception. In other words, we have previously established here that the exposures to diagnostic radiation which is generally in this one rad range results in genetic damage that eventually leads to diseases in the children. Now we would like to extend this analysis to adults exposed to radiation. Today I'll show that these low levels of ionizing radiation produce substantially increased risks of leukemia and other diseases, in particular heart disease, to the person exposed to the x-ray. From the adult data, we can get a dosage response curve which shows graphically, for the first time, what is going on at these levels.

Since this is a discussion for the public and since it may not be clear just what a dosage response curve is or why it is important here, let me take a few moments to explain this point. A dosage response curve is simply a graph where the dosages are plotted on the horizontal axis for the one rad range or slightly above it. On the vertical axis we plot the response as measured by, for example, increased risk of leukemia or other diseases. Our response variable is the proportion of the population that is affected by the x-ray received. The dosage response curve, therefore shows the relationship between the level of dose received and the biological effect of that dosage level.

Much of the controversy that has been going on for some years about whether or not there are hazards at the one rad level, concerns the shape of the dosage response curve and, in particular, it's linearity--that is whether it is a straight line or not. It is however, somewhat misleading to put this emphasis on whether or not the curve is a straight line because it is not simply departure from linearity that matters. We must ask ourselves: What does such a departure imply? Some departures from linearity can lead to a serious overestimation of hazards, others to serious underestimation, and still others to a relatively minor bias in the estimates. What is really crucial to the validity of the extrapolation is the way in which the dosage response curve behaves when the dose gets down into the one rad range.

Now let me show you a hypothetical set of dosage response curves to illustrate this point.(slide 1=new; theoretic curves) If the dosage response curve looks like the one shown in A, it turns sharply downward as we get to the one rad level. This would imply that there was a threshold or cutoff, a claim which has often been made but for which there is no good supporting data at all. If the curve looks like B, which you see continues as a straight line, then of course the linear extrapolation will give a correct estimate. Finally, if the curve flattens off as in C, as it gets down to the one rad range, this is from the public health standpoint, the worst possible case. If this happens then the extrapolative estimates can seriously underestimate the actual risks in the one rad range. Now we will be able to settle this question when we see the curves for the dosage response a little later. You've just seen the theories, and when I show you the facts it will be easy to see which theory is probably right.

You might ask: Why hasn't all this been done before? After all, the Tri-State survey was carried out around 1960. While there are a number of reasons for the long delay in getting facts before the public, our case is by no means exceptional. In the September 1977 issue of the Journal of the National Cancer Institute, there are 3 studies of breast cancer, all of which are based on data on exposure in the 1940's and 1950's. One of the reasons for adversary science hearings is to try to cut the length of time it takes to give the public the facts about environmental hazards. If I waited to publish what I will be talking about today, it would be at least a year or two before the information was in print.

However, not all delay can be blamed on the communication process. Sometimes we just don't know how to do a good analysis the first time we see the data. We have to learn from the data as we go. This was what happened both in our study of the Tri-State data and in Mancuso's study of the Hanford data. In both cases it was necessary to develop from scratch new analytic, biostatistical technology that could cope with the data. Existing technology was inadequate for the purpose. There have been serious technical difficulties which made it hard to develop a good dosage response curve for the one rad range in the past. Now I think these difficulties are being overcome.

I won't attempt to go into these technical difficulties at this point, because these technicalities are not really important. The general problem, however, can be seen very easily. The response we focused on, leukemia, is a very rare disease. Therefore you need an enormous population base followed for a fairly long period in order to get a sufficient number of leukemia cases to have a good analysis. In this instance we have approximately two thousand leukemia cases available for study. This is, relatively speaking, a very large series. And we also need a good comparison or control group. In the Tri State Survey, the comparison group consists of a genuine random sample, of the population base, something that is very rare in epidemiology. The sample was taken at the same time in the same area and with the same technology as the leukemia survey.

This study is one of the few epidemiological studies that was done "double-blind". In other words, persons being interviewed did not know that they were being interviewed about leukemia and the persons doing the interviewing did not know whether they were interviewing a person for the random sample or the controls. The key questions that might have helped the interviewer to guess the status of the household were kept to the end of the schedule. There are few surveys conducted today which are nearly as good as this one. That this study was so many years ahead of it's time is due to the foresight and competence of Dr. Abraham Lilienfeld who conceived it and set it up. So we are starting with the best data of its kind that is currently available.

Here is an example of the data that comes out of the Tri-State survey. In the slide you see Table 2. (Slide 2=Table 2 of JAMA paper) We will see Table 1 in a moment. This slide gives the observed and expected counts in the children aged 1-4 years. So let me take a little time to tell you what the numbers in this simple table mean, because you will be seeing more complicated tables like it. There are two series shown, one marked "leukemia" and one marked "no leukemia". The "no leukemia" children are from the random sample controls that are used in this survey as representatives of the general population. Now there are two categories for the indicator disease: No and Yes. This means "no indicator disease" or, "yes, an indicator disease was reported". In other words, where there is a yes answer, the child had one or more of the following childhood diseases: asthma, urticaria, eczema, pneumonia, dysentery, or rheumatic fever.

The numbers shown as observed numbers are the actual counts for the children in the Tri-State leukemia data. For instance, there were 27 cases observed in the interviews of leukemia households where there was no report of an indicator disease and only three where such a disease was reported. What we are looking at in this table is the children where there was no report of an x-ray exposure to either parent or to the child. The numbers called "expected", which you see directly below the 27 as 27.7, are the numbers predicted by the mathematical model which describes how the Tri-State survey was carried out and what the various risks of diseases are. The model simply gives in mathematical language an accurate description of what went on in the Tri-State survey. Since there is no radiation reported here the model does not involve radiation hazards.

We can now whether the model fits the facts. To do this we compare observed and expected. What you can see very clearly from this table is that the observations and the expectations are very similar. Therefore we can say the theory fits the facts. If we want to get fussy, we can calculate a goodness-of-fit statistic by subtracting observations from expectations, squaring them and dividing by the expectation. This summary statistic is called "Chi-square". It isn't important to go into what this is all about, it's a technical aspect. What matters is that if the number turns out to be relatively small, the fit is good. This objectively confirms the impressions we get by simply looking at the data.

You might wonder "Why are you looking at all those other childhood diseases when you are mainly concerned with the risk of leukemia from radiation in the one rad range?" The answer involves a basic scientific problem that underlies most of the technical problems here. The problem is: Among in the leukemia cases there will be some cases that are produced by the radiation. But there are going to be many other cases that are produced by extraneous factors in the environment--possibly background radiation, possibly chemical exposures, or possibly still other variables. We would like to have some way to distinguish those cases which are due to the radiation from those cases which are not. Unfortunately, we can't exactly do this. What we can do is take a step in this direction by finding other diseases with the same cause. The breakthrough here came when we found some clues that the radiation produced both leukemia and the indicator diseases.

What this means in practice is that if we focused our attention on the relatively small number of persons who had reports of certain other diseases as well as leukemia, then the cases we were looking at were much more likely to be produced by the radiation than those in the rest of the series. In other words, this provided an enriched series where, in a probability sense (and I emphasize only in a probability sense), we are dealing with persons who were more likely to have had their leukemia produced by the diagnostic radiation. In the remainder of the series, the cases would be relatively more likely to have their leukemia produced by other factors.

As far as the general public is concerned I don't think it is difficult for anyone to see this point: If radiation produces leukemia and certain childhood diseases, then we are going to be able to see the effects of radiation most clearly if we look in a series where the individuals were given diagnostic radiation and where there was a report of the childhood diseases as well as the leukemia.

Now this is what we have done but to do it we had to develop a mathematical model. To show you what a mathematical model looks like, and where the "expected numbers" come from, I'm going to flash another slide (Slide 3-Table 1 JAMA). It shows the formal statement of the model in mathematical language. The mathematical details of the aglebra need not concern us. Whenever there are questions about algebraic operations, these are always resolvable in principle (and usually in practice) simply by doing a series of arithmatic computations. In other words, this is not a matter of opinion, it is simply a matter of going through the calculations. People can agree reasonably well when this is all that is involved.

The details of the model are not particularly important. One point to note is the distinction between the basic model and the adjusted model. The first does not involve radiation and the second brings in the hypothesis about radiation that we want to test.

There are always technical difficulties with models. Coping with their problems is largely a matter of experience with models. We have 20 or 30 publications dealing with mathematical models applied to actual cancer situations--breast cancer, leukemia, various other situations. We know what we are doing when we deal with models. To put it bluntly, not many other people can do this job. Most mathematicians don't know enough about biology and about cancer to create this kind of mathematical model. Most biologists and epidemiologists don't know enough about mathematics to do it. The problems that these folks have with mathematical models often seem insuperable to them. We know the problems can be overcome because we have done this job successfully many times.

As far as the public is concerned, there is no reason to worry about the algebra. Algebra is simply another language. We can express our ideas in this language about as well as in verbal language. It's the ideas that matter and not the language in which they are expressed. The hypothesis which I have mentioned, namely that radiation can produce diseases of childhood in addition to leukemia, is something which we can express in the mathematical language fairly easily. In the "adjusted model" at the bottom, the radiation hypothesis is expressed in algebraic language.

Now some people find it hard to accept the notion that the same factor can produce more than one disease, something which tied up the cigarette-cancer issue for a long time. Nowadays we know of many environmental factors which can produce a multiplicity of diseases. Again some folks like to quibble about the assumptions of a mathematical model. But these quibbles aren't science. There is a rule in science for settling such matters. It doesn't make any difference whether you express the results in a mathematical language or a verbal language, the rule is the same. The rule goes back to Galileo, so it can be called the Galilean rule. It's simply this: A theory must fit the facts.

The Galilean rule should be the primary yardstick for validity in any adversary science hearing. The Galilean rule has been the hallmark of genuine scientific theories since Galileo first used it to demolish the Aristotelian theories of motion. The mark of a real scientist is not an advanced degree, Ph.D. or M.D. or anything else-- it's strict adherence to the Galilean rule. In radiation controversies, there is often a conflict between the results obtained by using the Galilean rule and those based on "expert opinions" of professionals. In principle, this should never happen.

Any opinion or hypothesis is a theory. If it is contrary to fact, it must be rejected. So when a professional opposes fact with expert opinion, it is a warning to the public that the professional is not speaking as a scientist but as spokesmen for his professional interests. It doesn't matter whether the individual is an engineer or a nuclear physicist, or a health physicist or a biostatistician or epidemiologist or anything else. There should be no excuse for deviating from the Galilean rule which is the scientific counterpart of the adage "Honesty Is the Best Policy".

Anyone who adheres strictly to the Galilean rule that theory must fit the facts is really serving only as a spokesman for the facts. This is my position when I make statements that are validated by the data. It is facts and not my opinions that determine what I say. I am only a spokesman of the Tri-State data. I am trying to tell you, the public, what the data has to say about the hazards of radiation in the one rad range.

Does our theory fit the facts? The next slide (slide 4=Table 3 JAMA) shows how we can answer this question precisely when we express the theory and the facts precisely. We've seen in the first slide that the basic model fits the facts very nicely when there was no report of radiation. When there is a report of radiation to mother and fetus, something new has been added. The next slide (Table 3) shows the situation in the case where the x-ray was delivered to the mother and fetus.

Again you can see immediately, without going into the technicalities, that the model that worked in the previous slide fails to fit the facts in the table on the left. However, the table on the right for the "adjusted model" fits quite well. The table on the left assumes there is no radiation effect and we have to reject this assumption. The table on the right is the "adjusted model" where a specific hypothesis about the nature of the radiation hazard is used in the calculations. This hypothesis is confirmed by the good fit to the facts.

Whether this hypotheses is stated in plain English or a mathematical language, what the model assumes is this: There is a certain part of the population that is affected by exposure to low level radiation and the rest of the population is not affected by the radiation. The distinction between the affected and unaffected group is that in the unaffected group the risks are the same as before (as in Table 2) for both leukemia and the indicator diseases. On the other hand if an individual is affected, then the risks of the leukemia and the risks of the indicator diseases will both be markedly increased.

Now to get numerical expected values, you have to put numerical estimates of these risks into the equations. They are called "estimates of parameters". The abstract quantities are called "parameters". The three parameters here are: (1) the proportion of individuals affected by the radiation, (2) the relative risk of the leukemia in the affected series (here the number taken is 50, which means that the risk is 50 times greater than it would be in an unaffected individual) and, (3) the relative risk for the indicator diseases (here taken as 5 which means that the risk is increased five-fold). Now when we use this adjusted model in the calculations then we get the expected numbers shown under the heading "adjusted model".

There is a working rule called Occams' Razor, which is a medeival name for the theological principle "Never multiply entities without necessity". We don't introduce a whole new set of parameters unless we really need them. Now do we need them here? This we can see by looking at table 3 and the relationship between observed and expected in the basic model and then in the adjusted model. If we look at the situation for the-original model, we see that in the catagory of indicated diseases there are 12 cases observed but only 3.4 expected. So we are seeing a model that fails to fit the facts. If we want quantitative evidence of this we can calculate Chi-square and this tells us that the model fails. When you look at the corresponding entries for the new or adjusted model you see that the numbers are 12 and 12.0. The numbers don't fit perfectly in all the cells, but basically what we have here is a model which does fit the facts. It is not necessarily the only model that will do this, but it is a model that fits the facts. This means that we have a scientific reason to prefer the adjusted model to the original model.

In this way we confirm the hypothesis of the model that radiation produces genetic damage that will be expressed in the child as indicator diseases and leukemia.

The task of the scientist doesn't stop with the single 2x2 table of table 3. We need to look at other age groups or radiation exposures and this is what we have done. For example in this particular body of data, we can look at the situation for all of the age groups in the next table (Slide 5=Table 4). What you can see from table 4 is that the observed and expected values aren't in perfect agreement. They should not be perfect because there is always sampling variation. This is what Chi-square is all about. However, you can see directly that the expected numbers are similar to the observations in all of the cells of Table 4. Even more important, the expected values have the same patterns as the observations. In the radiated group there are always more children where both indicator diseases and leukemia are found than would be expected if there was no radiation damage. On the other hand, in the data where there is no radiation delivered, the original model fits rather well and is validated as a description of the Tri-State Survey data in the absence of radiation. The more complicated "adjusted model" involving radiation effects is validated by data that does involve radiation exposures.

Let me emphasize one point which is sure to come up, and in a way, illustrates the advantages of having everything formulated precisely in a mathematical language as opposed to informal statements in a verbal language. Since its just about impossible, to honestly deny that there is a strong relationship to radiation showing in this data, the main line of defense for those who want to argue that there is no radiation effect is to claim that there is some other explanation. In technical terms this is called a counter-hypothesis. The nature of the counter-hypothesis varies but the general idea would be that, yes, there is a relationship between indicator diseases and leukemia but this comes because indicator diseases are in some sense precursors of the leukemia. This is the kind of issue which can tie us up in knots if we don't have a clear understanding of what is going on.

If you look at the series where there is no radiation then you can see that the observations and the expectations are in good agreement. This particular model involves the assumption of independence. Now what does that mean? That means that we assume that there is in fact no correlation between the indicator diseases and the leukemia in a situation where there is no common cause, that is to say in a situation where there is no radiation.

Suppose there really was a correlation between the diseases themselves. Then looking at the totals in Table 4 for the series with no report of radiation you ought to see more cases than expected of indicator diseases and leukemia. As you see, there are less. There are 7 cases observed, compared with 8.5 expected. The counter-hypotheses doesn't fit the facts. If it was correct, there should have been 15 or 20 cases instead of only 7. So the counter hypothesis of hypothetical correlation is refuted by the data.

It is important not to get mixed up in technicalities here. It is not a matter of ruling out absolutely any and all counter-hypotheses. This might be necessary if we wanted to show beyond a shadow of a doubt that the explanation that we are offering is the only explanation. However, for a prima facie case, this is not necessary. In practice in public health, it's impossible. You can never really rule out all hypotheses that might be raised simply, because anyone with any ingenuity can always raise a new one. But anyone who claimed to have refuted our findings by simply raising this counter-hypothesis would for practical purposes be lying to the public in a technical language. Anyone seriously proposing a counter-hypothesis, must match it against our hypothesis and show that it can do substantially better. Otherwise by Occam's Razor this simple and straightforward model would have priority. None of our opponents have done this so far and I don't think we are going to see it today either.

Without trying to go into all the details of the data for the mothers who received radiation prior to conception or for the fathers who received radiation prior to conception, I will simply show you two more slides of the situation with the model and the data for these further cases. In (Slide 6=Table 5 Data from Raj, on preconception radiation) you can see that the theory fits the facts nicely when we are looking at preconception radiation to the mother, in this case a very purified series that we haven't shown before. Here the preconception radiation to the mother is the only radiation reported. What we find is that the data fits the facts with parameters which are not much different from the previous parameters, in this case the relative risk is 60 not 50, but the overlap of confidence intervals suggests the risks are similar. So we have again confirmed, using a different body of data from the data on the pregnancy exposures, that the radiation is producing serious hazard.

What is particularly useful about this data on mother's preconception exposure is that it rules out some further counter-hypothesis which have been raised. The situation here is that, unless you are prepared to believe in sympthetic magic, the only way in which radiation delivered to the mother prior to conception can have an influence on the occurrence of leukemia and other diseases in the child after conception is to have produced genetic damage to the egg cell. This damage is transmitted to the child when the egg is fertilized and later expressed as leukemia. There is really no alternative to a genetic explanation other than outright mysticism or obscurantism. The other nice feature of this purified data is that in effect the leukemic process is started at conception and irrespective of the time when the actual damage occurred.

So we have, in effect, synchronized the data here and this gives some interesting results which I won't have time to go into. However, again, let me emphasize we can clearly rule out the counter-hypothesis that the damage is not genetic but some sort of damage to cell membranes, or is transmitted in some other way. It is either genetic or magic.

Now, the next slide (Slide 7=Fathers Preconception Radiation) which is Table 5 shows a corresponding data for fathers with the exposure prior to conception. Again there is a good fit, essentially using similar though not identical paramaters. The parameter value is a little lower this time, it's about 25 instead of 50 but that's really not terribly important. What is important is that a model with the notion that radiation is producing both the indicator diseases and leukemia will give an adequate description of what is going on in the real world. The numerical values of parameters of that model may be important if we are going to exploit these particular parameters in certain ways, but this is not a critical issue here. It can, however, be a big talking point if people want to make a big fuss about technical details in an attempt to obscure the issue.

There has been some criticism of our use of 1% as a parameter value for the percent effected by the radiation. Whether this parameter value is 1% or 1/10 of one percent or 2% it does not change the fact that we have shown that serious radiation hazards exist. In practice it is difficult to get a very precise estimate of these numbers from any one body of data. What we must try to do is get more and more information, more and more data, so we can gradually narrow down the estimate. I would defend 1% only as a reasonable estimate to take on the basis of what we have found in looking at all of the childhood data and on some information from other studies. It is quite possible that this estimate would have to be revised--but that is part of the natural evolutionary process of the sciences. As we learn more, we do change our minds about parameters. But this has really little or nothing to do with the question as to whether there are serious radiation hazards being produced. The original model is still being used irrespective of the parameter values. So however you slice it, those hazards are there.

Again, let me emphasize, my job is to present a strong prima facie case for hazards. I think that what we actually have here is a much stronger case, much better evidence and much more conclusive evidence than just a prima facie case. But I am not arguing that this is conclusive because I only need to make a prima facie case for the hazard. This I have done. Now what you have seen so far has been a test of the hypothesis that radiation in the one rad range can produce serious health effects. Note that we are talking, in this case, about leukemia in the child and other childhood diseases. These are the diseases we have looked at. This doesn't mean these are the only diseases the genetic damage will produce. I think we are missing a great deal of the health hazard because, for example the children who have more serious genetic damage as a result of the radiation are not going to make it all the way to age 6 or 7 or 8 and then get leukemia. They are going to die in the first year, in which case they are excluded from this particular survey. Or they may die even earlier, and be counted as the neonatal deaths or stillbirths. Probably, there are also spontaneous abortions produced by this kind of genetic damage.

In other words, we are seeing only part of the problem in this particular body of data perhaps the "tip of the iceberg". The genetic damage we can't study is probably producing many more deaths among children than the damage that we can detect. Therefore, we should not permit genetic damage to workers in the nuclear plants by allowing the exposures in the one rad range which are currently allowed under the NRC standards. Let me go one step further and say flatly I think that it should be an NRC policy that persons in the childbearing ages, men or women, should not be working in these areas where there are these high level exposures.

If somebody has to work there, it should at least be a person who is past the childbearing age, who is not going to put genetic damage into future generations. Because the other side of the coin is that the child may survive despite the damage--this can happen according to our model. That damage will be expressed in the next generation or the generation after that. We have put permanent genetic damage into the population. This is something which I think we cannot allow. Therefore the NRC should set regulations which essentially exclude persons in the childbearing age from this kind of exposure.

Existing regulations to the effect that the woman who has become pregnant should be warned to stay away from radiation, (as she might be warned off cigarettes) do not provide protection. The workers, of course as you can see, may be exposed prior to pregnancy and still have the damage. Moreover, when women are in early pregnancy they are often not even aware of this. So, that this kind of regulation is a fraud on the public. We cannot afford to have this kind of paper tiger or fake protection for workers any longer. The Nuclear Regulatory Agency has to bite the bullet and write really protective regulations.

Occasionally in this talk I will speak of matters which are matters of opinion rather than matters of fact. At this point you might wonder: How does the x-ray to the parents actually produce all these diseases in children. I will now say something about processes that lead to leukemia, about what happens between the time that the x-ray does the damage to DNA and the time when leukemia occurs. This necessarily involves some speculations that are not established by factual evidence. We don't know all there is to know about this process. However, we have a fairly good idea of what is going on and I think it is important to give some explanation, even a somewhat speculative one. There should be no aura of mystery or magic as to why there is a relationship between the exposure to radiation and the occurrence of multiple diseases.

Whenever one talks about underlying mechanism or machinery or processes, there are likely to be lots of technicalities. However, the main points can be understood without going into these technicalities. For example, we are concerned with the damage produced by the x-ray in the structure of the DNA in human genetic material. This is what I will mean when I speak of "genetic damage". We know that there has to be some kind of genetic damage because the initiation of the process by the x-ray does not immediately produce leukemia. Leukemia takes perhaps five to ten years to develop. Before there can be leukemia, the misinformation that is put into the cell by the x-ray damage has to be duplicated and reduplicated millions of times. We know this because it takes a large white cell population to produce the leukemia. This is not something produced by a single cell.

The initiation of leukemia by the x-ray is a strictly physical process. However, the process that goes on between that point and the time leukemia develops is necessarily a biological process. In fact, it is an evolutionary process. From a mathematical model which I won't discuss today, we could get an idea of how misinformation in a cell can impair feedback machinery that controls the white cell population. It is probably the failure of the feedback control that leads to excessive numbers of white cells. This is what leukemia is all about.

My main point, though, is that the misinformation in the DNA produces say the loss of an enzyme, and affects more than that part of the host defense system represented by the white blood cells. Other host defense operations are also impaired or rendered less efficient by this damage. The same break-point in the DNA that is responsible for producing the leukemia, can be responsible for producing various other diseases as well.

The technical language used in talking about this kind of genetic effect is, I think, very confusing, not just to the public but to the people who use the language. It's based on outmoded ideas and misconceptions. Unfortunately the obsolete notions are built right into the technical language and therefore I won't use this language at all.

So let us speak in plain English about the implications of the degredation of DNA by x-ray that I have just described. The first important point that it does not take a very great amount of x-ray to produce the kind of genetic damage that will eventually lead to leukemia or other diseases. All that is involved in initiating the process is disruption of the delicate chemical structure of the DNA and relatively low levels of energy will suffice to do this.

While I'm at it, I might as well clarify a point, about the background levels to which all of us are exposed at all times. These are orders of magnitude lower than what I am calling low levels of ionizing radiation, but they still can produce damage to the DNA. Indeed, radiation-induced mutations are important in the evolutionary process.

At these very low levels to which biological organisms have always been exposed, we would expect that the evolutionary process would develop a compensating repair machinery for these levels. However, this machinery could not be expected to cope with the much higher levels of radiation that have resulted from advances in technology. Hence the most serious damage to human genetic material has occurred in this century as a result of technologies involving ionizing radiation. This is the damage that is of greatest concern in the public health sense and this is precisely the damage we are talking about, the damage in the one rad range. This is the heart of the problem.

Let me add a word about higher levels of radiation. Three papers have just appeared in the Journal of the National Cancer Institute which show what happens with exposures in the range between 100 rads and 1000 rads. The curves show that up to about 350 rads there is an increasing risk of breast cancer but at a still higher dose the risk may actually go down. The reason for this is that heavy damage to the DNA produces a cell which is not reproductively competitive. Roughly speaking, you could say that the breast cancer was "caused" and "cured" at the same time.

If you can see this one point, that the limiting factors are different in different dosage ranges--then you can see why we can't expect to learn too much about what happens in the one rad range by looking at data on dosages outside this range. Estimates obtained by extrapolating on a straight line assumption from data at high levels of exposure are dubious. The linear assumption breaks down within the high dosage range so it can hardly be expected to be meaningful in an order of magnitude below this range. So the only way we can really tell what is going on in the one rad range is to look and see what happens to human beings exposed in this range and that's exactly what we are doing now.

Now let me come back to the data that we have on the adults because this is new and I think especially important to our consideration of worker protection. Everything that we do has risks and benefits. Therefore when I suggest regulations prohibiting the employment of the individuals of childbearing ages in these hazardous situations, the price that would have to be paid would presumably be to expose persons over childbearing ages to this radiation. From my conversations with others it seems morally more acceptable for older persons to be employed, if they are told the risk,and get hazard pay, and guaranteed medical care. Although they may be creating problems for themselves, they will not be creating problems for future generations. Now I want to look at the hazards to the persons themselves exposed to low levels of ionizing radiation in the one rad range. We will also be looking at the risks of leukemia and at some heart diseases that are going to play the role previously played by the indicator diseases in the childhood studies.

The data is still from the Tri-State survey, but now we are looking at a somewhat different kind of leukemia. We are looking at the kind of leukemia that is common in adults, at non-lymphatic leukemia. We will be looking at men because previous analyses have shown that they have the clearest risks. Since we want to look into the data for the adults at these very low levels of radiation using a new technology, we want to start with the simplest situation we can. But it should not be assumed that because we are not reporting other risks that they don't exist. We are reporting on the risks that we have looked at first and where we found clearcut initial results.

As far as the nature of the data tables and the mathematical model goes, although there are some minor differences in the adults, they are a rather technical in nature, and I will not go into them in detail. The general appearance of the data and the general fit of the model in the adults is very much like it is in children although the parameters are somewhat different. For evidence that the theory fits the facts I will show the next table, (Table 7=Slide 8 Data for Adults Latest Obs. Exp.) in which you can see we have the data for the men in 3 age groups and at various dosage levels, in terms of the estimated number of rads delivered to individuals.

Now I have not dealt with the x-ray dosages in the children. Exposure in the children were reported as yes or no. In the adults we ate dealing with dosages. Anytime you deal with dosages in radiation you open a can of worms.

You can hassle about the dosimetry forever. For instance should you calculate the dosages in rads or rems? You can make a big confusing, utterly unintelligible discussion of the whole matter and completely cloud the issue. This happened to me in dealing with the mammography issue where I reported to the National Cancer Institute staff in Silver Springs in the spring of 1976, on the hazards of this x-ray. We wasted maybe an hour discussing the dosimetry for the mammography and whether the 2 rad dose that we had used in our calculations was appropriate. It turned out that no one was really arguing that this dosage estimate was inappropriate. The experts were arguing about all the technicalities of what the two rads might mean or might not mean. I think that the discussion of dosimetry and the material presented earlier will hopefully bypass this kind of confusion.

So what I will do is to say what we did and what numerical values are used. In this particular situation, whatever values can be faulted. However, if somebody else thinks they have a better set of values, the logical thing to do is to change the parameters and redo our work. What this will tend to do is to slide the curves down the X-axis or move them along down the Y-axis. It will not greatly change the shape of the curves--which is what is important here.

What we did was use the formula shown in the next slide. (Slide 9= Formula, new, Rzepka material). We are not really relying on the particular formula for the validation of the findings. We have a validation from the data itself. If we are using worthless estimates, then what will happen is the effects will all wash out, and we will be left with flat curves. In other words, there won't be any dosage response curve at all. So when we find dosage response curves, they are self-validating. This is how questions about dosimetry should be answered. Does the theory fit the facts? All this hassling over personal opinions about this or that dosimetry procedure is a waste of time, in my view.

The next table, Table 7, (Slide 10=Slide 8) shows the adult data and you can see that it fits the facts nicely just like the previous data. The model, which is in many respects is very similar, has quite different parameters. We are now talking about a proportion affected which is of the order of 5% rather than 1%. We are talking about relative risks which are very much lower, of the order, for instance of about 10 instead of 50 for the relative risk of leukemia and 3 instead of 5 for the relative risk of heart disease. Again, let me remind you that the role of the other diseases used in this analyses is to allow us to make some better separation between those cases of leukemia which are produced by the radiation and cases of leukemia which are produced by other factors. In the adults, this problem is even more difficult than in the children.

Now the tables that you have seen so far maybe somewhat confusing. They really just show you that the theory fits the facts. We can use the validated theory to get somewhat more of an idea what relative risks are, what the proportion affected are, and the magnitude of the radiation hazard. But now I can show something which makes it a little easier to see directly how the radiation hazard at low dosage levels affects the person exposed. Using the same data that I have just shown we can now go ahead and construct a dosage response curve.

This is shown in the next slide which is Figure 1. (Slide 11= Conf. Intervals) What you can see on the Y axis of Figure 1 are 95% confidence intervals on the proportion affected for the oldest age group in the series, that's the men over 65. The X-axis shows the dosages calculated from the formula that I have just shown.

What you are looking at is something which has never been seen before, it is a new result. And it is the first dosage response curve in the one rad range for leukemia in adults. It is an example of what can be gotten out of the mathematical model as you go further and further into the analysis. We didn't even have confidence intervals in the first paper reported on children--but that was the first paper. We now have the dosage response curve complete with confidence intervals. We are now able to get a direct estimate of the doubling dose for leukemia from this data. We can put confidence intervals on this estimate. So a mathematical model as essentially an instrument like a telescope or microscope. It allows you to see deeper into the data than would otherwise be possible.

This is the whole point in doing the mathematics. It's not for window-dressing, it's not for show, it's not to play games, it's to get a better look. Unfortunately mathematics is not always used this way. It's often used for window-dressing, as in the Rasmussmn Report. It isn't the mathematical language per se that matters, it's the way that you use it. You can use mathematics as a natural language for describing what is going on in the world or as an abstract language for playing games. It is very often used for the latter purpose, in critiques and in ERDA reports. Used this way, mathematics is merely another language that can be used to lie to the public.

Getting back to the dosage response curve itself, I think there are a few things you can see right away but let me point them out just for clarity. First you will notice that the curve doesn't look very linear. It starts with a relatively low slope and then seems to go up faster. You will notice that when it gets up higher it is getting outside the one rad range.

The shape of the curve here is not something which is forced into the data by any assumption such as a linear assumption. The curve can go anywhere it wants to. As you will see, it occasionally goes down slightly, but usually goes up. When you look at the confidence intervals you can see quite clearly that it tends to go up. You can see the lower limits of some of the confidence intervals are above the upper limits of other confidence intervals. There is no question that there is a positive slope but the curve of the slope seems to be changing rather than constant.

When I started, I said that the critical question that we would try to answer would be: What happens to the dosage response curve as you get down into the one rad range? Does the curve suddenly drop off, does it go down very sharply? Let me refresh you memory of that slide. (Slide 11=Slide 1) Those were the theories. Now you have seen the facts. The dosage response intervals don't entirely distinguish between a straight line and other increasing curves, but we can certainly rule out the possibility that the curve drops down to zero at any point. So the notion that there is threshold is flatly ruled out.

This is very important. The notion that below some so-called "threshold dose", radiation becomes harmless is clearly contrary to the facts. (Slide 13=Slide 11) The technologists who have often made this claim have jeopardized the lives of hundreds of thousands of Americans and the health of their children by insisting on this self-serving myth. The myth "justified" the promiscuous use of radiation at the dosages at the one rad range. Those who asserted this myth "in the name of science" were lying to the American public.

In the next slide (Slide 14=Doubling Dose) which is Figure 2, you can see how the use of the mathematical model can be extended even further, in this case to an estimate of the doubling dose. What you see is the plot of the values of Chi-square on the Y axis against the estimate of the doubling dose which is on the X axis. The minimum of this curve, which you can see is around 5 rads, provides an estimate of the doubling dose. Again we can get confidence intervals on this estimate. However I don't want to go into this in any depth. There are a lot of technicalities involved and also I have some personal reservations about the use of this doubling dose for high exposures.

My main reason for making this estimate was as a check on the work reported by Mancuso, Stewart, and Kneale. The estimates of Mancuso, Stewart and Kneale were well below ours, a little less than one rad. An Updated analysis gives 3.6 rads which is now in good agreement with our estimate.

The estimates that come from of the BEIR report using linear extrapolation range from say 25 to 50 rads to 100 rads. They are far above ours. What this slide indicates is that the hazards in the one rad range are an order of magnitude worse than the estimates obtained by the linear extrapolation. In other words, the difference between 5 rads and 50 rads in the doubling dose estimate shows that use of the BEIR estimates to set so-called "safe" dosages does not protect the public or workers. That's why we must cut these dosage levels by at least a factor of 10.

I would hope that by showing you this factual evidence, all of these tables and graphs and pictures, I have not confused you. What all this boils down to is one simple argument: Suppose we take as a working hypothesis that there is a serious radiation hazard at low levels of ionizing radiation. Suppose that the x-ray produces damage to the DNA that will be expressed in the child later as leukemia and childhood diseases or in the individual himself as leukemia and heart disease. Then we can explain quite adequately and precisely the data actually found in the Tri-State Survey. The hypothesis fits the fact. However, we cannot explain this data without assuming some kind of serious radiation hazard.

There could be some legitimate argument about whether the parameters are exactly right. There can be counter hypotheses about the underlying mechanism that explains how x-ray damage to DNA can eventually produce leukemia and the other diseases. This is really irrelevant. The main point is that without a radiation hazard hypothesis you can't explain this data. With that hypothesis you can. Note also, this is not data on a couple hundred rats given a very high dose of saccharin. We are talking about data on about 13 million human beings, exposed to diagnostic radiation in the one rad range. We are talking about excellent scientific data, really the best of its kind. We are talking about a careful scientific analysis not just a casual look at the data. We come out with the conclusion that there are very serious human health hazards in the one rad range. This is much stronger than a prima facie case, but I am saying that it is at least a prima facie case for this hazard.

That means that we have got to stop looking at dosages under 5 rads per year as harmless, as something we can tolerate. It doesn't matter now whether we are talking about workers in the nuclear industry, or persons who are getting diagnostic x-ray, such as CAT scans. It doesn't matter now exactly what kind of radiation technology is producing the hazard, the point is the hazard is there. We have got to do something about it unless we are willing to give all our children and our children's children a curse that will go on for generations and generations.

Now I think that the data that I have presented represents a prima facie case. If my opponent wants to argue this point, he has to do more than say this or that is wrong. It is up to my opponent to show that there is any other way to explain this data without assuming that there is a very serious radiation hazard in the one rad range. He has to present an argument which would justify the claim that there is no serious radiation hazard in this range and that it is safe to leave the level at 5 rads per year for nuclear workers. I don't think he can do this.

A REPORT ON THE ACTION OF TWO FEDERAL AGENCIES, ERDA AND NCI, IN TERMINATING FUNDING FOR TWO MAJOR STUDIES OF THE HEALTH HAZARDS PRODUCED BY LOW LEVELS OF IONIZING RADIATION

A response to a question raised by Senator Adlai Stevenson III,
during the testimony of Doctor Irwin Bross at a hearing
of the Committee on Commerce, Science, and Transportation
on June 17, 1977

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July 5, 1977

INTRODUCTION

At the June 17 hearing of the Committee on Commerce, Science and Transportation chaired by Senator Adlai Stevenson III, Dr. Irwin Bross made the following statement in the course of testimony on major new findings in radiation hazards in the "one rad range" (100 millirads to 10 rads):

"These major scientific achievements in the past year might seem to deserve a Nobel Prize, but, in point of fact, in both cases the reward was a cutoff in the funding of the research by angry radiation technologists at ERDA and angry radiologists at NCI."

The matter came up in cross-examination as follows:

"Senator Stevenson: Now, you said that funding, your funding, was cut off by angry radiation technologists at ERDA.

Dr. Bross: No. At NCI. Both of these programs had their funding cut off. Mancuso was supported by ERDA, and ERDA cut his funding. And right in the middle of some very important findings, too.

Our funding is from National Cancer Institute, on a program which I was renewing, which I had for nine years. And that is a different source of support.

Senator Stevenson: Those are serious allegations against those two agencies. Can you amplify your comments?

Dr. Bross: Senator, I would be glad to do that at length, but I do not feel my personal problems should interfere with my other testimony, because I am here to testify on behalf of the public health, and not my own interest. And so I would be glad to talk about that to anyone who would talk to me. But if I would...

Senator Stevenson: But these are serious allegations against those two agencies. In terms of them, they ought to be substantiated. We do not have to go into it now.

Dr. Bross: I believe I could present you with the factual information on this to substantiate both of the charges, both for ERDA and for NCI.

Senator Stevenson: All right. I would like to follow up on that account, and also with some additional questions in writing. We are running out of time now."

The following statement was prepared in response to Senator Stevenson's request. Insofar as possible, it is restricted to statements for which there is documentary evidence, where factual backup is available even if it is not cited, or where there is an eye-witness testimony (concerning the site visit). Because of this restriction, this response will deal more fully with the NCI peer review process than the ERDA review. Dr. Bross attempted to obtain documentary evidence for the Mancuso decision from ERDA under the Freedom of Information Act but with limited success.

MATTERS OF RECORD

While the original statement in the June 17 testimony is correct as it stands, it is a somewhat informal way of making a serious charge against two federal agencies, ERDA and NCI. Therefore a more formal restatement of the charges seems appropriate. Since there are components of the original statement which are matters of record, these will be dealt with first so that the restatement of the charge can be as brief as possible.

It is a matter of record that the requests of the principal investigators of the two research teams that were carrying out these studies on the hazards of low levels of ionizing radiation for funds to continue this research were disapproved. ERDA has already cut off the Mancuso funding and the NCI has disapproved renewal of the Bross program in September 1978. Again, it is a matter of record that the scientific findings of both studies, independent but mutually collaborative, indicate that the health hazards in the one rad range, determined from data on humans actually exposed to this level of nuclear or diagnostic radiation, are far more serious than had previously been estimated. They are orders of magnitude worse than the estimates by linear extrapolation from high dosage levels presented in the BEIR report*, long the basis for regulatory policy.

It is again a matter of record that the disapproval of both funding requests involved use of the machinery of what is called "peer review". The procedures used by ERDA differ in detail from those used by the NCI, but the essential characteristics of the peer review process is the same in both cases. The decision-making involves a small number of professionals chosen by the agency. Decisions are made in secret and reporting of the results is anonymous. There is no appeal under ordinary circumstances. The decision-makers have no accountability to the public but are accountable to the agency in the sense that their reports go to the agency. The closed character of the peer review process reflects the philosophy that decisions on professional matters should be made by professionals and the public should be excluded. With minor variations similar procedures are used in decision-making by all of the "Big Science" federal agencies that have multi-million-dollar budgets. The crux of the issue here is the way in which the peer review machinery was used in the decisions to cut off funds.

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*BEIR report: The Effect on Population of Exposures to Low Levels of Ionizing Radiation. National Academy of Science, 1972.

Finally it is a matter of record that the peer review process in each instance was primarily focused on a specific scientific report. The ERDA decision concerned the study of deaths among the workers at the Hanford Reprocessing plant by Mancuso, Stewart and Kneale. This material will shortly appear in Health Physics (Exhibit 1). The NCI decision was somewhat broader, but again the focus was on the study of genetic damage from diagnostic X-ray by Bross and Natarajan that appeared in the Journal of the American Medical Association on May 30, 1977 (Exhibit 2). The somewhat unusual circumstances that make the materials at issue readily available to the public also serve to open the closed peer review process to more critical examination than would ordinarily be possible.

RESTATEMENT OF CHARGE

In the original informal statement the charge was that for both the Mancuso and Bross research programs (identified more fully in the previous section) there was a "cutoff in the funding of the research by angry radiation technologists at ERDA and angry radiologists at NCI."

This charge can be stated somewhat more fully and formally (using the matters of record given in the previous section) by making the following five points, each of which will be detailed subsequently:

(1) Both federal agencies have policies, programs and professional personnel involving radiation technology, in-house and grantees, and a strong motive to block or suppress further research on the hazards of low-level ionizing radiation.

(2) Both federal agencies had the means to stop further research by using the easily manipulated peer review process as an instrument for cutting off further funding for the two programs.

(3) Both federal agencies used the peer review process to produce the desired verdict, primarily by selection of persons and panels whose professional interests were threatened by the scientific findings. ERDA used in-house reviewers and NCI used radiologists and other professionals despite the clear conflict-of-interest involved.

(4) The manipulation by both agencies precluded any objective scientific review of the two research programs. The review was not carried out by the scientific "peers" of the investigators. The NCI site visit was disrupted by an angry radiologist. The resultant NCI

"critique" supporting the verdict was little more than selected adversive statements, scientifically irrelevant "putdowns" of the program.

(5) As a result of the actions of the two federal agencies the American public has been deprived of research of vital importance to the public health and public policy (particularly energy policy), freedom of inquiry by American scientists has been restricted, and the integrity and credibility of the medical and scientific community has been eroded by this abuse of the peer review machinery.

SUBSTANTIATION OF POINT 1

This section deals with-the point that "Both federal agencies have policies, programs, and professional personnel involving radiation technology, in house and grantees, and a strong motive to block or suppress further research on the hazards of low-level ionizing radiation".

The long-standing and close connections of ERDA, its sister agency (NRC) and their common predecessor agency (AEC) with the nuclear industry is too well known to require documentation here. That ERDA has policies, programs and professional personnel that are directly connected with radiation technology, both in ERDA and in institutions or corporations funded by ERDA again seems a matter of common knowledge.

The findings of the Mancuso, Stewart and Kneale research (Exhibit 1) are clearly a threat to the multi-billion nuclear industry. For example, the excess deaths from leukemia and lung cancer occurred for exposures of Hanford workers at dosage levels that were nearly always within the 5 rad level permitted by the AEC and currently by the

NRC. Dr. Bross plans to present his findings (Exhibit 2) on health hazards in the one rad range at a special hearing this Fall as part of an effort to obtain reduction by a factor of 10 in permissible levels by the NRC. Operations at much stricter levels would add to nuclear industry costs and might even result in the prohibition of certain nuclear processes, particularly some of the more hazardous reprocessing operations. The resistance of the nuclear industry, ERDA, and the NRC to this tightening of permissible levels is also common knowledge.

Apart from the general threat from the Mancuso, Stewart and Kneale findings, there is a specific threat to ERDA and its contractors. The nuclear industry has long insisted that no one has ever died from exposures occurring in the regular nuclear operations (exclusive of major accidents) but the Mancuso findings show that leukemia, lung cancer, breast cancer and other malignant diseases are produced by the exposures that occur in regular operations. There are, therefore, well-documented deaths that have occurred and this may lead to lawsuits by exposed nuclear workers against federal agencies, such as ERDA, and companies that were contractors for ERDA or AEC. Such threats provide ERDA with a strong motive to block further research by the Mancuso, Stewart and Kneale team.

Documentary evidence in support of the contention that ERDA and its allies with a large stake in nuclear technology have a strong motive to suppress research is provided by the efforts to block publication of these findings. Exhibit 3 (correspondence with Dr. Karl Morgan) begins with a letter from Dr. Karl Morgan to Dr. Irwin Bross, asking him to review two seemingly contradictory papers and to explain the reason for the contradictions. The letter states "Now NRC is determined to suppress publication of the latter paper". This refers specifically to an earlier draft of the Mancuso, Stewart and Kneale paper that is Exhibit 1.

The Morgan letter indicates that efforts to suppress a previous paper by Milham were successful and suggests a historic pattern of suppression of information on low levels of ionizing radiation. Although it would be too large a task to document this history here, it might be noted that the action against Mancuso by ERDA is the latest in a long series of similar actions going back about 25 years. At that time, the AEC was determined to suppress the information about the hazards of fallout (again, a hazard from low levels of ionizing radiation) which threatened the nuclear weapons testing programs (then conducted above ground). The AEC embarked on a continuing policy of retaliating against scientists who publicly discussed these radiation hazards. Anyone interested in establishing this pattern of suppression and repression by the AEC should take testimony from Drs. Gofman, Tamplin, Morgan, Sternglass and others who were the predecessors of Mancuso.

Let us now turn to the policies, programs, and professional personnel of the NCI that are directly involved with radiation technology. These are not as well known as those of ERDA. Nevertheless the NCI commitments to medical radiation technology are substantial. Of special relevance here are NCI programs involving radiation surveillance of asymptomatic populations. The largest and best known of these is the controversial Breast Cancer Detection Demonstration Programs (BCDDP) in which a guideline against screening women under 50 was issued in August 1976 because the radiation hazards far outweighed the benefits in this group of women. Dr. Bross played a public role in forcing the NCI to stop rescreening of the women, a role that did not endear him to the radiologists. The attitude of the radiologists is indicated by the fact that they ignored the NCI guideline while continuing to accept NCI funds (although it is against federal laws to fund NCI programs which are not in compliance with guidelines). Documentation concerning the BCDDP and its radiologists has been submitted in conjunction with testimony by Dr. Bross before the Intergovernmental Relations and Human Resources Subcommittee of the Committee on Government Operations (Fountain Committee) on June 14, 1977. It includes a statistical analysis that indicated the non-compliance with the guideline.

The NCI is involved with many other programs involving radiation technology and the radiologists constitute an important "constituency" of the NCI. They have been favored with over-representation on committees (as will be indicated subsequently) and with support for various programs involving the use of X-ray (such as the therapeutic adjuvant programs). Other NCI programs, such as the Centers Programs, encourage funding or justification for the purchase of costly radiological equipment. This is also documented in the testimony and supporting documents provided to the Fountain Committee.

Documentary evidence that radiologists feel threatened by the new scientific findings (and that the proponents of radiation-based programs at the NCI would likewise feel threatened) is provided by the reaction of radiologists reported in the Buffalo Courier Express. Exhibit 4 shows reaction to the same material (as published in the Journal of the American Medical Association) that was presented in the peer review of the Bross renewal proposal. As will be seen subsequently in the first section dealing with Point 4, the angry, defensive reaction of radiologists was the same in both cases. They feel personally and professionally threatened by the new facts and findings and this provides a strong motive for retaliatory action. Note that there is no serious effort at scientific rebuttal (just technical-sounding double-talk). There was the same reaction from radiologists during the peer review.

SUBSTANTIATION OF POINT 2

This section deals with the charge that "Both federal agencies had the means to stop further research by using the easily manipulated peer review process as an instrument for cutting off further funding for the two programs".

The use of the peer review instrument by the NCI will be described and documented in detail in subsequent sections. The available documentation for the ERDA employment of this instrument is more restricted, but what is available will be presented in this section. It will at least suffice to document Point 2 for ERDA. The peer review process is mentioned in the correspondence, memorandum, and letter in Exhibit 5 which constitutes (together with Exhibit 6) the totality of information received under the Freedom of Information request. Otherwise Exhibit 5 is rather uninformative.

There is some limited and censored information in Exhibit 6. A summary concerning the Mancuso program was prepared by Sidney Marks, M.D. The initial material (of the document labeled "Enclosure 2" has a heading labeled "Outside Reviews" (page 1, line 14) but there is nothing further. The spacing does not suggest that anything was censored out but that there was no outside review involved in this part of the document. The "Inside review" heading is followed by an extended description of components of the program and a section labeled "Evaluation". Thereafter there is a section labeled "Review" in which outside reviewers are mentioned but the names have been eliminated and the reviews themselves were not provided. Therefore it is unclear whether the "Evaluation" reflects any outside review.

Although the "Evaluation" gets into some technical areas, there is one striking point which a non-expert reader can immediately see. In the list of "deficiencies in performance under the contract" there are such complaints as "reluctance to initiate analysis", "reluctance by the investigators to publish in edited journals", "quality of statistical expertise" and of the "statistical analyses". Each of these deficiencies was corrected in a very effective way. The analyses were carried out. The work was accepted for publication in Health Physics (an "edited journal"). Outstanding epidemiologists and statisticians were brought in for consultation in the persons of Dr. Alice Stewart and Mr. George

Kneale. Dr. Stewart has been for many years a leading epidemiologist in the study of low-level radiation hazards, particularly pelvimetry hazards. A new statistical technology was developed to estimate latent periods and doubling times from the Hanford data, an important contribution to science.

The non-expert can see very clearly that the correction of the "deficiencies" did not make the slightest difference in the ERDA plans on page 4 of Exhibit 6. Nor can it be said that the correction of the deficiencies came after the decision was already past the point of no return. The date of Exhibit 6 is "1/8/76" but it refers to an "unedited document in connection with a presentation of a health physics symposium". This is the original version of the Health Physics article. It has Dr. Stewart and Mr. Kneale as co-authors. It uses the methodology and obtains the important results that appear (with small arithmetical changes) in the Health Physics article. Therefore ERDA knew that the deficiencies had been corrected. It also knew that the scientific findings that were a threat to the nuclear industry had been obtained.

Under these circumstances, the statement on page 4, line 35 of Exhibit 6 in the section on "ERDA Plans for the Health and Mortality Study" reveals the intentions of the federal agency:

> "The sensitivities associated with the study of workers in the nuclear industry constitute a compelling argument for providing an orderly transition from the current to a new principal investigator".

One possible translation of this into plain English would be: "The Mancuso findings could be disastrous for the nuclear industry and therefore control should pass to someone who can be relied upon to disparage the work of the previous principal investigator and subsequently kill the study."

That this objective would not be difficult to achieve is suggested by the section on page 4 labeled "Reviews". Starting on line 10, it is stated that:

> "Outside reviews by (name censored) and (name censored) were unfavorable. Both reviewers felt that Dr. Mancuso's call for additional funding and enlarged study population is not justified".

One of the reviews was clearly not so bad. Thus it is stated that "(name censored) complimented the investigators on their careful, meticulous work to date". In peer review, one reviewer can do the hatchet job: "(name censored) recommended that the study be turned over to a different principal investigator". The information was not obtainable from ERDA but it would be relevant to know the name of this investigator and any subsequent connections of this person with ERDA as a consultant on this or other programs.

SUBSTANTIATION OF POINT 3

This section deals with the charge that "Both federal agencies used the peer review process to produce the desired verdict, primarily by selection of persons and panels whose professional interests were threatened by the scientific findings."

The documentation on this charge will have to be limited to the NCI because the Freedom of Information request to ERDA failed to produce a list of names or affiliations of the persons responsible for the ERDA decision. The only two identified individuals, Dr. J.L. Liverman and Dr. S. Marks, have long-standing involvement with ERDA or AEC. The motivation discussed in Point 1 applies to them.

The panel making the NCI decision, however, is clearly identified. A roster of the panel is given as the attached schedule, Exhibit 7. The panel is the Clinical Cancer Program Project Review Committee (CCPPRC). As its name suggests and the roster shows, the panel is almost entirely composed of M.D.'s, there being only one Mr. listed on the regular panel. One ad hoc member, Dr. Samuel Greenhouse, is a statistician and was the chairman of the site visit team. Of the 20 persons listed on this roster, 7 have titles which indicate a direct connection with radiation technology. Dr. Enrico Mihich has informed me that he absented himself from the session because of conflict of interest. He is from RPMI, the institution submitting the grant proposal. He was, however, the only one who left to avoid conflict-of-interest. None of the radiologists saw any conflict of interest.

The conflict-of-interest is especially clear here because of the involvement of the research program under review in the controversy over the screening of women under 50 by mammography in the Breast Cancer Detection Demonstration Program (BCDDP). Radiologists participating in this review were on the opposite side of this controversy. Findings from sophisticated biostatistical and mathematical analyses ("meta-technology") which were carried out by the program up for renewal had supported the findings of Dr. John Bailar III* that the BCDDP benefit-to-risk ratio was around 1-to-1. They refuted the widely-publicized report of Dr. Rodney Withers of the M.D. Anderson Hospital that the ratio was 125-to-1. As Dr. Bross had publicly pointed out, Dr. Withers made a gross arithmetical mistake in using estimates from the BEIR report. Dr. Withers is one of the CCPPRC members.

The composition of the site visit team reporting to the CCPPRC is shown as Exhibit 8. It reflects the composition of the CCPPRC with 6 of the 9 members being M.D.'s. One of the M.D.'s. Dr. Philip Cole, has credentials as an epidemiologist; the others have no special qualifications to judge the programs. Apart from the chairman there was one statistician and one academic geneticist. The composition of the committee will be further discussed in the substantiation of Point 4 where, in particular, the activities of Dr. Herman Libshitz, a radiologist from M.D. Anderson, will be discussed. Dr. Libshitz is a colleague of Dr. Rodney Withers and is also involved in the mammography controversy. The conflict-of-interest noted here will be shown in the material on Point 4 to have directly influenced, even disrupted, the site visit.

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*Editor, Journal of the National Cancer Institute

SUBSTANTIATION OF POINT 4

This section deals with the point that "The NCI site visit was disrupted by an angry radiologist".

Unlike most of the previous evidence, this section includes eye-witness testimony of the events at the NCI Site Visit of February 17, 1977 by Dr. Irwin Bross, the principal investigator of the renewal proposal under review. The composition of the site visit team was cited earlier in Exhibit 8. The agreed-upon agenda for the site visit is Exhibit 9. It shows there were 6 projects for review, 3 involving radiation research and 3 involving other topics. Three of the projects were to be reviewed in the morning, the rest in the afternoon.

This was a tight schedule. However, this research program had been operating for almost 8 years and all 6 projects were starting from new leads that had recently been published. The past performance of the program, such as the productivity shown in Exhibit 10 and Exhibit 11, was believed to be more than sufficient to justify renewal. These exhibits were part of the grant application for the renewal of Grant No. CA-11531 submitted in September 1976, copies of which were distributed in advance to all of the site visitors. An update of publications was distributed at the site visit and is included in Exhibit 10.

The agenda was the first casualty of the attack on the first project led by an angry radiologist, Dr. Herman Libshitz. This project was defended (Exhibit 9) by Mr. Natarajan and involved the material on genetic damage from ordinary diagnostic radiation (Exhibit 2) that was subsequently to be published in the _Journal of the American Medical_

Association (though this was not known at the time of the site visit). The attack continued all morning and was still going strong when the site visitors finally adjourned for lunch.

The questioning, led by Dr. Libshitz, returned over and over again to the kind of questions that amateur epidemiologists always ask. Dr. Libshitz was mainly assisted in his efforts by two other visitors. One was Dr. Wolff Kirsch who, as ad hoc member of the parent committee, was supposed to plead the case for this program to this committee. Another was an academic geneticist, Dr. Charles Sing, whose research has received support from ERDA-AEC funds although this is not a very frequent source of support for academic geneticists.

The questioning employed such tactics as asking an elementary question and then interrupting the reply with another question. For example, Mr. Natarajan was repeatedly asked about the obvious distinction between the delivery of X-rays to the mother prior to pregnancy and during pregnancy. It does not take a geneticist to realize that if the effect is leukemia in the child, then in one instance the genetic damage must be to the mother's cells and in the other instance to the fetal cells. Dr. Sing kept insisting that Mr. Natarajan did not understand the distinction although the latter had just completed an article comparing the two situations.

After the first few minutes, it should have been clear to the Chairman that Dr. Libshitz and his cohorts had come to kill the program and that the Chairman had to act firmly if there was to be a fair hearing.

The amiable but ineffectual Chairman, Dr. Samuel Greenhouse, was unable to control the proceedings. As a result, Dr. Libshitz accomplished his purpose. The schedule was completely disrupted. The bitter first session set up an adversary relationship between the reviewers and those reviewed. The negative tone, once set, ran through the rest of the site visit. The scientifically irrelevant but adversive "putdowns" got into the pink sheet, though the responses did not. Letting Dr. Libshitz achieve this purpose was like allowing a tobacco company representative to disrupt a site visit on research on smoking hazards.

It should again be noted that rigging a site visit does not require that all visitors be hostile. A few determined persons can control a panel that has a majority of fair-minded but uninvolved scientists. Here, for example, the one person who was qualified to speak, Mr. Jablon, said very little at the visit or in the pink sheet. Mr. Jablon was the working statistician on the Japanese A-bomb study. The only M.D. with epidemiological credentials, Dr. Philip Cole, intervened several times to try to correct Dr. Libshitz's misconceptions about epidemiology. He gave up, however, after a few fruitless attempts. Dr. Greenhouse, the chairman, was completely out of his depth.

The end result was that the site visit was dominated by persons who had neither epidemiological, biostatistical, nor mathematical competence to evaluate the methodology of the radiation studies. This particular site visit got completely out of hand, which is somewhat unusual. However, lack of competence on the part of reviewers is not uncommon in peer review operations.

SUBSTANTIATION OF POINT 4 CONTINUED

This section deals with the point that "The resultant 'critiques' supporting the verdict are little more than selected adversive statements that are scientifically irrelevant 'put downs' of the programs".

Failure of ERDA to provide documentation for the "critiques" used in the Mancuso decision despite requests under the Freedom of Information Act necessitate the use of the NCI "pink sheet" where this documentation is available. This document is appended as Exhibit 12.

While the nature and language of Exhibit 12 is similar to other NCI pink sheets, it is longer than usual. Instead of a single sentence or paragraph, the document goes on for pages. It contains the usual cliches or "putdowns" that are used in rejecting epidemiological studies. These ordinarily tend to be such vague generalities that, although they may sound devastating to a non-expert reader, the statements can be "safely" made about almost any study.

Perhaps because of the additional length, this pink sheet is more informative than the usual one. The reviewers indulged in "overkill", the inclusion of more deleterious statements than were needed to kill the proposal. Such statements are more specific because the intent is to deeply wound the investigators under review (who might shrug off generalities). The "overkill" stands out especially clearly because of the hypocritical praise of the principal investigator that was put in as a precaution at the top of page 12 of Exhibit 12. The "overkill" statements are useful here for two reasons. First, they are refutable by factual evidence. Second, they show malicious intent.

The natural reaction of a scientist to a catalogue of adversive statements is to attempt a point-by-point rebuttal. This will not be done here for two reasons. First, the technical-sounding adversive statements tend to be "safe" cliches which can almost always be used as "putdowns" for a study and are in this sense "unanswerable". Second, by trying to answer the "putdowns", a scientists gives the non-expert reader the impression that there is a genuine disagreement between experts. The non-expert may feel then that there is no hope of resolving such a disagreement.

Fortunately the publication of the papers (which are the main target of criticism in the ERDA and the NCI peer reviews respectively) gives a non-expert a way to avoid the technicalities. After reading the seemingly devastating "scientific" criticisms, the non-expert might reflect that if even half of these "putdowns" had any scientific validity, it would be extremely unlikely that these articles would ever have been published in journals as conservative as the Journal of the American Medical Association or Health Physics. The non-expert might also note that the bitterly attacked material in the adult leukemia study (Project V of Exhibit 9) has also been accepted for publication by the Journal of Medicine.

On the other hand, a brief review of a few of the injudicious "overkill" statements suffices to eliminate any pretense of an objective scientific evaluation of the studies. The first example is on page 11, line 37 of Exhibit 12 where it is clearly not needed in the context of the discussion. This spiteful statement is:

> "The justification for the core budget, however, seems to have been based on the past performance of the principal investigator. His past work was considered by the reviewers as above average. Yet, little progress seemed to have been made during the past three years."

This statement appears in connection with requests for funds covering administrative costs (e.g. part-time administrative assistant and secretary), not scientific functions. This "overkill" statement is directly refutable by factual evidence that was supplied to the site visitors, a list of approximately 100 publications produced by the team in the last three years (see Exhibit 10). Several major scientific findings were also listed (Exhibit 11). A crude articles-per-dollar index can be used for comparison with other NCI programs. It is unlikely that any proposal approved and funded by the parent committee (CCPPRC) had even half the productivity-per-dollar of the grant under review. Indeed, this productivity cannot be matched by very many NCI grants reviewed in any category.

An even more informative example of the way the "instant experts" of review panels "put down" work which they can't even understand is this pontification from page 13, line 4 of Exhibit 12. This is in the Summary and therefore would involve both panels.

> "As for the group's reported progress in mathematic modeling, namely, Dr. Bross's development of the deep mathematical model, it was not clear to the reviewers that the work thus far has led to any deeper understanding of the cancer process or relationships than has been gained by conventional analysis."

This judgment may sound impressive until it is recalled that it is a pronouncement by M.D.'s (and Ph.D.'s who are not strong mathematicians) on research that has gone on for more than ten years and has produced more than a dozen mathematical papers. The ability of the reviewers to read (let alone criticize) this work can be readily judged by any non-expert reader. An intelligent reader is on par with an M.D. when it comes to reading about sophisticated mathematical models. Exhibit 13 shows the nature of this research. The two papers by Dr. Leslie Blumenson provide the underpinning for the Bross and Blumenson paper which contains the evaluation of mammographic screening which refuted the radiologists. (Personal aside: Dr. Bross will personally and publicly apologize to any member of the review panels who will take and pass a short written test of comprehension of these papers). This statement illustrates the willingness of this panel to making adversive statements on material that they greatly dislike but don't understand. It also shows that the pink sheet is a basically fraudulent document.

Another example of "overkill" illustrates that even "safe" cliches happen to fail here. On page 13, line 1 of Exhibit 12 there is a denegration of the investigators data that should really hurt:

> "A third major defect seemed to be the lack of a systematic attempt to validate information in records, procedures which are part of all sound epidemiologic studies."

As was repeatedly emphasized orally and in writing, the Tri-State data that was analyzed here comes from a study set up almost 20 years ago by Dr. Abraham Lilienfeld*. The arrow aimed at Dr. Bross hits an innocent but distinguished epidemiologist. This safe cliche fails here because the Tri-State Survey is famous in its own right as the best data base of its kind. It has been used in more than a dozen different published studies by well-known epidemiologists. This statement in the pink sheet shows that the reviewers had not done their homework and weren't listening.

A non-expert who reads the pink sheet for "tone" (as opposed to content) will note that while the tone is relentlessly negative for the radiation projects, in other projects it sounds more positive or even encouraging. This is evidence of the intention of the reviews to try to shift the direction of research away from radiation hazards to some safer area. This intent (which is contrary to NCI guidelines) is made even more explicit on page 2, line 10 of Exhibit 12 (the crucial last line of the resume):

> "In recommending disapproval of the proposal, the Committee members expressed the hope that the applicants will reconsider this latter direction for their future studies."

The "latter direction" is indicated in the previous sentence:

> "Given its present monolithic structure, where this group seems most likely to make worthwhile contributions is in the conduct of straight, epidemiologic investigations."

---

*Distinguished Professor, The Johns Hopkins University

Clearly the doctors reviewing the studies regarded the study of cigarette hazards as "epidemiology" and the study of occupational hazards as "epidemiology" but the study of radiation hazards produced by doctors is not "epidemiology" but "medicine". Hence, one translation of the two above statements into plain English is: "If you want any future NCI funds, stay away from sensitive research on radiation hazards".

In sum, the cited evidence from the pink sheet shows that it was window-dressing for the verdict stopping the radiation research. There is no semblance of an objective scientific evaluation. In this respect, however, the operation of peer review machinery in this instance is not entirely unusual.

SUBSTANTIATION OF POINT 5

The purpose of point 5 is to point out some of the implications of the actions taken by the two federal agencies.

The termination of important research in progress deprives the public of potentially important new scientific knowledge of the hazards of low-levels of ionizing radiation. This knowledge is of vital importance both in protecting the public health and in making realistic decisions on energy policies.

The cut off of funding to the two scientific programs will discourage American scientists from doing research in sensitive areas--particularly areas with major fiscal effects as well as health effects. This government intervention to suppress the truth in a sensitive area is, unfortunately, exactly what we have accused other countries of doing.

Finally, use of the peer review machinery that brings in members of the scientific and medical community to provide respectable "cover" for a process that has been rigged to produce a desired verdict leads to the erosion of the integrity and credibility of these communities. The sincere scientists and physicians used as dupes by the agencies have the best of intentions. This does not, however, exempt them from responsibility. Their reluctance to speak out has encouraged corrupt use of peer review machinery by "Big Science" federal agencies.

The charges against ERDA and the NCI are not necessarily charges in the legal sense. It is not clear what, if any, laws are broken in rigging a peer review to produce a desired verdict. What is clear is that this is against the public interest and against the long-term interests of the scientific and medical communities as well. If legislation is needed to stop these abuses, then this would seem a high priority task for a President and a Congress with a public commitment to reform.

TABLE OF CONTENTS

FOR EXHIBITS

Exhibit 1

Mancuso, T.F., Stewart, A. and Kneale, G.: Radiation Exposures of Hanford Workers Dying from Cancer and Other Causes. (Presented at the Tenth Midyear Symposium of the Health Physics Society, Saratoga Springs, New York. October 11-13, 1976; Revised Draft, March 1977). Health Physics, in press.

Exhibit 2

Bross, I.D.J. and Natarajan N.: Genetic Damage from Diagnostic Radiation. Journal of the American Medical Association 237(22): 2399-2401, 1977.

Exhibit 3

Correspondence between Dr. Karl Z. Morgan, editor of Health Physics, and Dr. Irwin D.J. Bross (2 items):

a) Letter from Dr. Morgan to Dr. Bross, December 14, 1976.

b) Letter from Dr. Bross to Dr. Morgan, December 30, 1977.

Exhibit 4

Buffalo Courier Express News reports on reaction to Bross and Natarajan reports (5 items):

a) "X-ray Report Angers Local Radiologists", June 2, 1977.

b) "Bross Cancer Grant Will Not be Renewed", June 4, 1977.

c) "Researcher Says Patients Should Make X-ray Decision", June 6, 1977.

d) "Low-Dose X-rays Termed Harmless", June 8, 1977.

e) "Dentist Says Abuse of X-rays Does Occur", Letter to the Editor, June 15, 1977.

Exhibit 5

ERDA response to Freedom of Information request (4 items):

a) Letter from Walter H. Weyzen to Dr. Bross, June 2, 1977.

b) Letter from Walter H. Weyzen to Dr. Bross, June 15, 1977.

c) Memo from Dr. Sidney Marks to J.L. Liverman, December 2, 1974.

d) Letter from Dr. Sidney Marks to Dr. Mancuso, January 16, 1976.

Exhibit 6

ERDA Response to Freedom of Information request: Critique of Mancuso study.

Exhibit 7

Roster of the Clinical Cancer Program Project Review Committee

Exhibit 8

Roster of Site Visit Committee.

Exhibit 9

Agenda of Site Visit.

Exhibit 10

List of Publications produced by program under review and Update as of February 8, 1977.

Exhibit 11

Principal Scientific Findings of program under review.

Exhibit 12

Critique of program under review.

Exhibit 13

Publications on mathematical modelling (3 items):

a) Blumenson, L.E.: When is Screening Effective in Reducing the Death Rate? Mathematical Biosciences 30, 273-303, 1976.

b) Blumenson, L.E.: Detection of Disease with Periodic Screening: Transient Analysis and Application to Mammography Examination. Mathematical Biosciences 33, 73-106, 1977.

c) Bross, I.D.J. and Blumenson, L.E.: Screening Random Asymptomatic Women Under 50 by Annual Mammographies: Does it Make Sense? Journal of Surgical Oncology 8, 437-445, 1976.

ITEM II. LISTING OF SLIDES

Slide	Designation (Source)*	Title
1	Figure 1 (NEW)	Theoretic Dosage Response Curves
2	Table 2 (JAMA)	Observed and Expected Counts in Children Aged 1-4 Yrs.
3	Table 1 (JAMA)	Algebraic Characterization of Mathematical Model
4	Table 3 (JAMA)	Model and Adjusted Model for Observed and Expected Counts in Children Aged 1-4 Yrs.
5	Table 4 (JAMA)	Extended, Adjusted Model for all age groups
6	Table 5 (NEW)	Observed and Expected Numbers of Children by Mother's Preconception Radiation Status, age and Disease Status
7	Table 6 (NEW)	Observed and Expected Numbers of Children by Father's Preconception Radiation Status, Age and Disease Status
8	Table 7A (NEW)	Observed and Expected Number of Men by Calculated Radiation Exposure (in Rads) and Disease Status (65 yrs. of Age and Older)
9	Formula 1 (NEW)	Formula Used for Calculations of Radiation Exposure (in Rads) for Tri-State Adult Data and Disease Status
10	Table 7B (NEW)	Observed and Expected Numbers of Men by Calculated Radiation Exposure (in Rads) and Disease Status (15-64 Years of Age)
11	Figure 2 (NEW)	Dosage Response Curve for Men (over 65) (95% Confidence Intervals on Percent "Affected")
12	Figure 1 (NEW)	Theoretic Dosage Response Curves
13	Figure 3 (NEW)	Dosage Response Curve for Men (over 15) (95% Confidence Intervals on Percent "Affected")
14	Figure 4 (NEW)	Estimation Procedure for Doubling Dose (Non-lymphatic Leukemia in Adult Man, Dose range 0-9 Rads)
15	Figure 5 (NEW)	Estimation Procedure for Doubling Dose (Non-lymphatic Leukemia in Adult Men, Dose range 0-50 Rads)
16	Table 8 (NEW)	Algebraic Characterization of Mathematical Model for Adults (not in planned presentation)
17	Table 9 (NEW)	Numerical Estimates of Parameters Used for Expected Values in Data Tables (not in planned presentation)

*Where not in slide, title label is on back of glossy print.

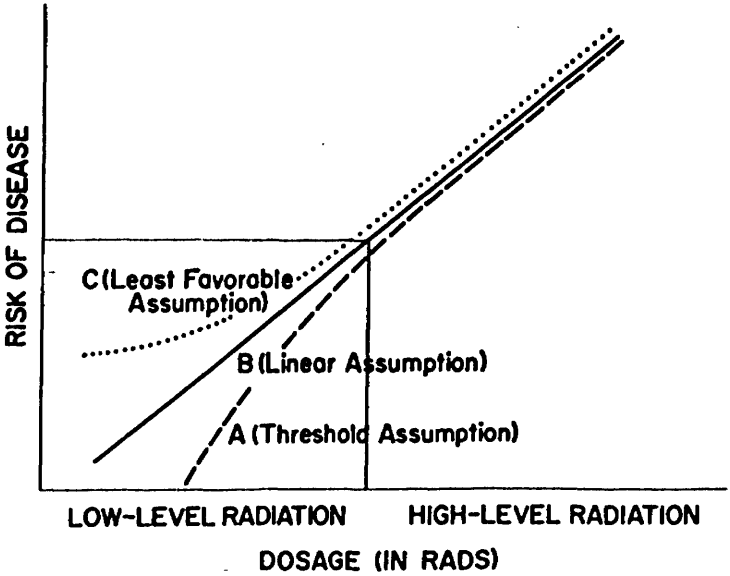

RISK OF DISEASE
C (Least Favorable Assumption)
B (Linear Assumption)
A (Threshold Assumption)
LOW-LEVEL RADIATION
HIGH-LEVEL RADIATION
DOSAGE (IN RADS)

Table 2.—Observed and Expected Counts in Children Aged 1-4 yr*

	Indicator Disease, No.	
	No	Yes
Leukemia		
Observed	27	3
Expected	27.7	2.9
No leukemia		
Observed	48	5
Expected	47.3	4.9

*Parents did not receive x-ray exposure.

Table 1.—Algebraic Characterization of Mathematical Model

Case 1: No Radiation Exposure Reported

The notation used is as follows:

X_1=Age group (0=1-4 yr, 1=5-9 yr, 2=10-14 yr)
X_2=Occurrence of indicator disease (0=No, 1=Yes)
X_3=Occurrence of leukemia (0=No, 1=Yes)
$D_0(X_1)$=Probability of at least one indicator disease
$L_0(X_1)$=Probability of leukemia
K=No. of yr in survey

The probability of a given status with respect to indicator disease, leukemia, and age is

$$P_0(X_1, X_2, X_3)=[D_0(X_1)]^{X_2}[1-D_0(X_1)]^{1-X_2}[L_0(X_1)\cdot K]^{X_3}$$
$$[1-L_0(X_1)\cdot K]^{1-X_3}$$

The expected numbers in a 2×2 table can be calculated using the following:

$N(X_1)$=No. of children in population in age group X_1
$H_0(X_1)$=Proportion with no radiation exposure
S=Sampling rate in random sample

So that $N(X_1)\cdot H_0(X_1)$ is the total number with no radiation exposure reported in the population in the age group X_1, and then the expected numbers for the individual cells in the 2×2 table are

$$E_0(X_1, X_2, X_3)=N(X_1)\cdot H_0(X_1)S^{1-X_3}\cdot P_0(X_1, X_2, X_3)$$

(Note that when there is leukemia, the sampling rate is 1.)

Case 2: X-ray During Pregnancy Reported

The notations used here are as follows:

D_1=Probability of indicator disease in group exposed to radiation and affected (ie, suffered genetic damage)
L_1=Probability of leukemia in affected group
A=Proportion affected by radiation exposure
H_1=Proportion with radiation exposure
So that $D_1=D_0\cdot R_0$ and $L_1=L_0\cdot R_L$ where
R_0=Relative risk of indicator disease
R_L=Relative risk of leukemia

As before, $N(X_1)\cdot H_1(X_1)$ is the total number with reported x-ray during pregnancy in the age group X_1 in the population.

Now, the probabilities for individual cells in the 2×2 table with radiation exposure contain two parts: The probabilities for those (1) who were exposed to radiation but not affected, and (2) who were affected by radiation. The probabilities for the former are the same as those with no radiation exposure reported, and the probabilities for the latter are

$$P_1(X_1, X_2, X_3)=[D_1(X_1)]^{X_2}[1-D_1(X_1)]^{1-X_2}[L_1(X_1)K]^{X_3}[1-L_1(X_1)\cdot K]^{1-X_3}$$

So, the expected values for the group with exposure to mother's radiation during pregnancy are

$$E_1(X_1, X_2, X_3)=N(X_1)H_1(X_1)S^{1-X_3}[(1-A)P_0(X_1, X_2, X_3)+A\ P_1(X_1, X_2, X_3)]$$

Table 3.—Model and Adjusted Model for Observed and Expected Counts in Children Aged 1-4 yr*

	Model Indicator Disease, No.		Adjusted Model Indicator Disease, No.	
	No	Yes	No	Yes
Leukemia				
Observed	45	12	45	12
Expected	32.7	3.4	42.3	12.0
No leukemia				
Observed	60	3	60	3
Expected	55.7	5.8	56.0	6.1

*Parents received x-ray exposure.

Slide 4

4871-1

Table 4.—Extended, Adjusted Model for All Age Groups

Age Group, yr	No Radiation		Radiation	
	Indicator Diseases, No.			
	No	Yes	No	Yes
1-4				
Leukemia				
Observed	27	3	45	12
Expected	27.7	2.9	42.3	12.0
No leukemia				
Observed	48	5	60	3
Expected	47.3	4.9	56.0	6.1
5-9				
Leukemia				
Observed	13	3	11	7
Expected	18.2	3.0	14.0	6.9
No leukemia				
Observed	79	13	53	8
Expected	77.8	12.8	51.2	8.8
10-14				
Leukemia				
Observed	8	1	4	4
Expected	11.9	2.6	5.1	3.8
No leukemia				
Observed	72	16	30	6
Expected	68.8	15.3	27.9	6.5
Total				
Leukemia				
Observed	48	7	60	23
Expected	57.8	8.5	61.4	22.7
No leukemia				
Observed	199	34	143	17
Expected	193.9	33.0	135.2	21.4

Slide 5

4871-5

Table 5.--Observed and Expected Numbers of Children by Mother's Preconception Radiation Status, Age and Disease Status.

	No Radiation		Radiation	
	Indicator Diseases, No.			
Age Group Yr.	No	Yes	No	Yes
1-4				
Leukemia				
Observed	27	3	19	7
Expected	27.9	2.9	24.0	7.3
No Leukemia				
Observed	48	5	30	4
Expected	47.6	4.9	20.5	3.3
5-9				
Leukemia				
Observed	13	3	4	4
Expected	18.5	3.0	4.5	2.5
No Leukemia				
Observed	79	13	19	0
Expected	78.7	12.9	16.2	2.8
10-14				
Leukemia				
Observed	8	1	0	1
Expected	11.9	2.7	1.3	1.1
No Leukemia				
Observed	72	16	8	1
Expected	68.3	15.6	6.9	1.7
Total				
Leukemia				
Observed	48	7	23	12
Expected	58.3	8.6	29.8	10.9
No Leukemia				
Observed	199	34	57	5
Expected	194.6	33.4	53.6	7.8

Slide 6

4935-6

Table 6.--Observed and Expected Numbers of Children by Father's Preconception Radiation Status, Age and Disease Status

Age Group Yr.	No Radiation		Radiation	
	Indicator Diseases, No.			
	No	Yes	No	Yes
1-4				
Leukemia				
Observed	27	3	36	13
Expected	27.7	2.9	38.9	14.9
No Leukemia				
Observed	48	5	65	9
Expected	47.3	4.9	66.4	7.6
5-9				
Leukemia				
Observed	13	3	9	6
Expected	18.2	3.0	10.9	5.0
No Leukemia				
Observed	79	13	43	12
Expected	77.8	12.8	46.6	8.2
10-14				
Leukemia				
Observed	8	1	4	3
Expected	11.9	2.6	3.5	1.9
No Leukemia				
Observed	72	16	19	7
Expected	68.8	15.3	20.9	5.0
Total				
Leukemia				
Observed	48	7	49	22
Expected	57.8	8.5	53.3	21.8
No Leukemia				
Observed	199	34	127	28
Expected	193.9	33.0	133.9	20.8

Slide 7

4935-83

Table 7A.--Observed and Expected Number of Men by Calculated Radiation Exposure (in Rads) and Disease Status (65 Years of Age and Older)

	65 Years	
	No Heart Disease	Heart Disease
	Less than 1 rad	
Leukemia		
Observed	14	9
Expected	17.43	8.27
No Leukemia		
Observed	17	5
Expected	17.92	4.98
	1-5 Rads	
Leukemia		
Observed	19	9
Expected	17.43	9.35
No Leukemia		
Observed	17	4
Expected	16.98	4.88
	5-10 rads	
Leukemia		
Observed	9	7
Expected	12.38	6.56
No Leukemia		
Observed	10	5
Expected	12.14	3.47
	10-20 Rads	
Leukemia		
Observed	13	10
Expected	11.68	11.76
No Leukemia		
Observed	4	4
Expected	6.62	2.74
	20 rads or more	
Leukemia		
Observed	6	5
Expected	4.66	6.40
No Leukemia		
Observed	1	1
Expected	1.15	0.93

Slide 8

4935-5

Formula Used for Calculations of Radiation Exposure (in Rads) from Tri-State Adult Data:

Rads = 0.167 (number of chest X-rays) + 0.790 (number of abdomen X-rays).

Numerical values came from Public Health Service X-Ray Exposure Study: Population Exposure to X-rays U.S., U.S. Department of Health, Education and Welfare, 1964; 1970.

Slide 9

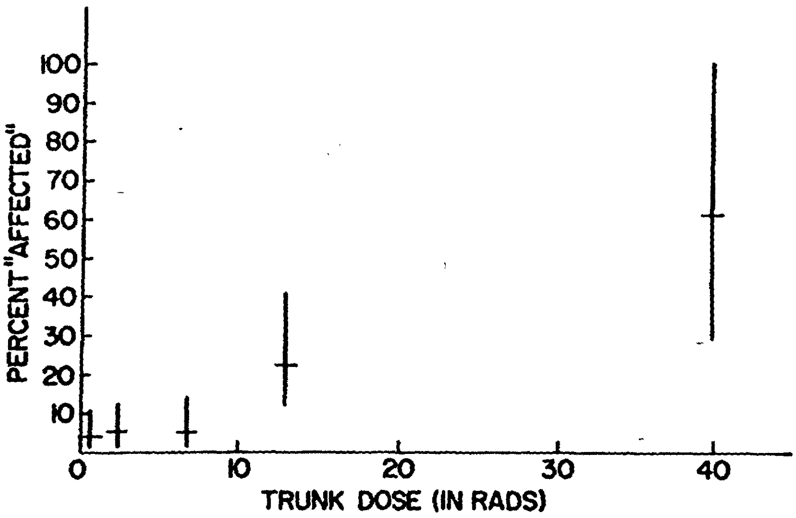
4871-2

Table 7D.--Observed and Expected Numbers of Men by Calculated Radiation Exposure (in Rads) and Disease Status (15-64 Years of Age)

	45-64 Years		15-44 Years	
	No Heart Disease	Heart Disease	No Heart Disease	Heart Disease
	Less than 1 rad			
Leukemia				
Observed	12	8		
Expected	15.98	3.72		
No Leukemia			Less than 5 rads	
Observed	49	5	26	1
Expected	48.89	7.47	25.01	1.95
			47	2
			48.97	2.12
	1-5 rads			
Leukemia				
Observed	14	10		
Expected	18.60	7.13		
No Leukemia				
Observed	40	1		
Expected	36.01	6.78		
	5-10 rads		5-10 rads	
Leukemia				
Observed	5	4	2	0
Expected	9.81	3.33	2.59	0.17
No Leukemia				
Observed	18	7	6	1
Expected	22.22	3.87	7.03	0.27
	10-20 rads			
Leukemia				
Observed	13	3		
Expected	10.58	4.99		
No Leukemia			10 rads or more	
Observed	12	4	1	1
Expected	13.48	3.21	4.49	0.39
			5	1
			5.94	0.31
	20 rads or more			
Leukemia				
Observed	5	5		
Expected	6.59	3.49		
No Leukemia				
Observed	7	0		
Expected	5.56	1.74		

Slide 10

4935-4



Slide 11

4543-1

Figure 2 Dosage Response Curve for Men (over 65) (95% Confidence Intervals on Percent "affected")

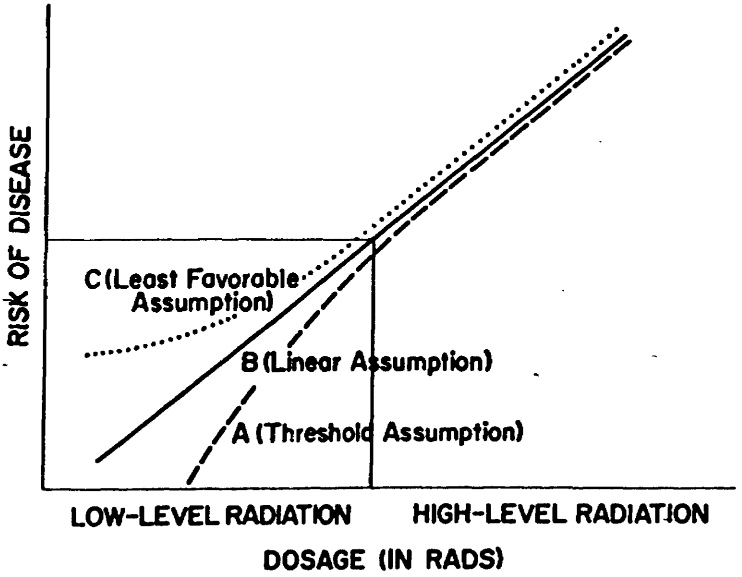


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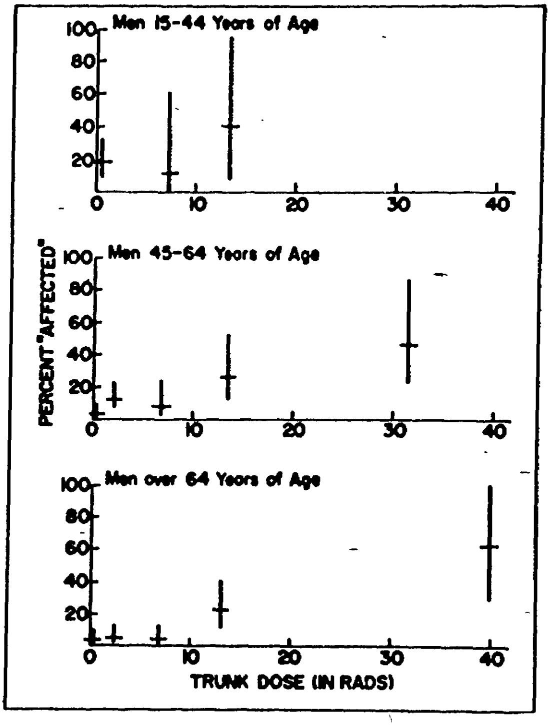
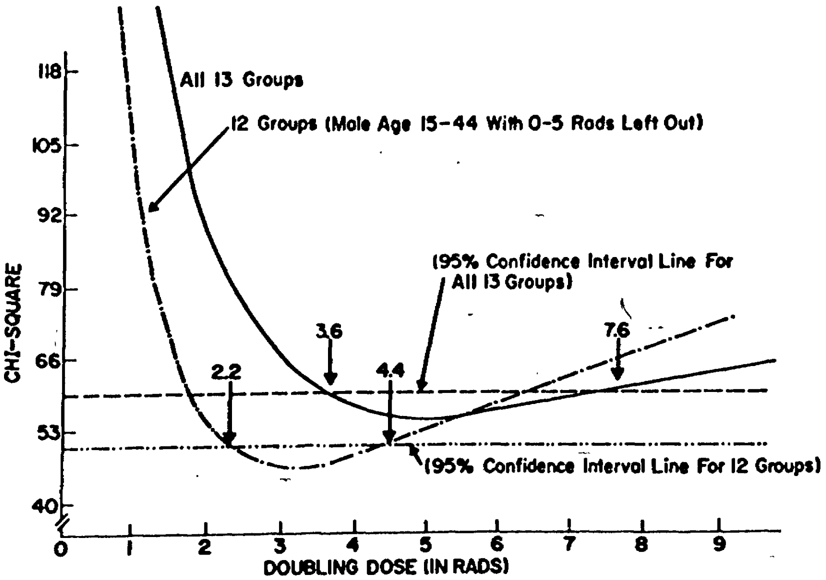
Figure 1 Theoretic Dosage Response Curves



Slide 13

4543-2

Figure 3 Dosage Response curve for Men (Over 15) (95% Confidence Intervals on Percent "affected")



Slide 14

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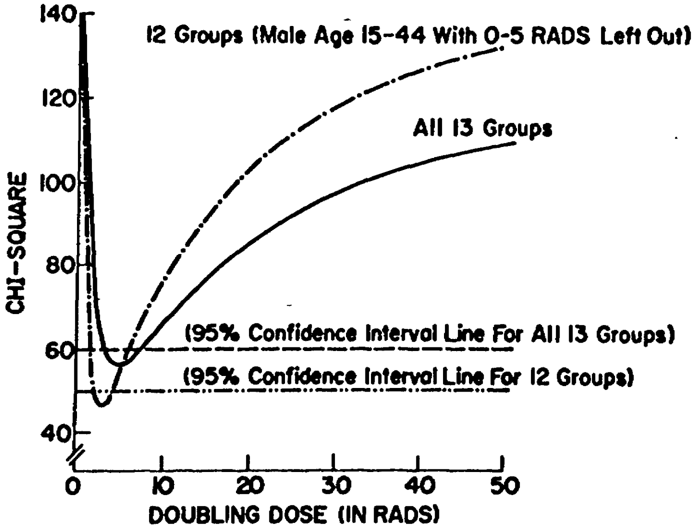
Figure 4 Estimation Procedure for Doubling Dose (Non-lymphatic Leukemia in Adult Man). Dose Range 0 – 9 Rads



Slide 15

4935-1

Figure 5 Estimation Procedure for Doubling Dose (Non-lymphatic Leukemia in Adult Men). Dose range 0 ~ 50 Rads

SUPPRESSION OF SCIENTIFIC RESEARCH IN THE U.S.: THE MECHANICS

Within the past two years it has become possible to make direct estimates of the risks of leukemia and other diseases from massive data on humans who may have been exposed to low levels of ionizing radiation (100 millirads to 10 rads). Mancuso, Stewart, and Kneale studied the exposures and deaths among more than 30,000 workers at the Hanford reprocessing plant. My team, which includes Natarajan, Bell, and others, studied exposures and disease histories for a population base of 13,000,000 persons with possible exposure to ordinary diagnostic x-rays. Both teams independently found that these direct estimates of risks were an order of magnitude higher than those expected from the extrapolative estimates from high dosages or animal studies such as those in the BEIR report. For example, we both found that the doubling dose for leukemia in males is less than the current annual permissible dose for nuclear workers set by the Nuclear Regulatory Commission.

The scientists and physicians whose livelihood depends on radiation technology were understandably upset by our scientific findings and the end result was that funding of our research was not renewed by ERDA or by the NCI. We became the most recent victims of a pattern of censorship and repression that has been going on in the United States ever since the furor over fallout from weapons. The earlier examples of this pattern and the cut off of research resources to Morgan, Gofman, and Tamplin are coming to light, for instance in a recent Jack Anderson column (3 Dec 1977). During these years the AAAS and Science have been loudly concerned about suppression in Argentina, the Soviet Union, and other countries but have maintained a discreet silence about what goes on in the United States.

There are, of course, differences in the machinery of suppression here and abroad. I am not writing this from a concentration camp. As the Watergate episode and other coverups by the CIA, FBI, and other federal agencies show, suppression in the United States requires the active participation of influential persons outside of the government and passive participation by many others. Peer review machinery was used to cut off funding for research with positive findings. This required the active participation of scientists, technologists, physicians, and other professionals. Keeping the research reports out of Science and other journals required action by persons in the upper echelons of the research community. So those of us who have been suppressed in the United States have the dubious consolation of knowing that this was done with the active or passive complicity of our colleagues in the AAAS and other societies.

If this is considered a blanket condemnation of the scientific community, then I am at least as guilty as anyone alse. Like many others in the AAAS and other societies, I never wanted to get involved in organizational politics. My interest was in doing research and not in the boring, time-wasting processes of grantsmanship and committeemanship that are almost mandatory in "Big Science" federal agencies such as AEC, ERDA, DOE, NASA, NCI, etc. This lack of participation is why the allies of Big Science have had so little difficulty in taking over the organizational machinery and journals of scientific societies. It was easy even though in the AAAS and other organizations the rank and file membership consists of "little scientists" such as myself. Most of us are guilty of not wanting to get involved with the politics of science.

The editorial policy of Science reflects this Big Science takeover of the machinery that had evolved for little science. Dr. Abelson has been associated with the AEC and the other Big Science agencies throughout his career. The editorials, news reports, and articles that appear in Science reflect this bias. Our research report on low-level radiation hazards was personally handled and rejected by Dr. Abelson. To my knowledge Science has never published a scientific report on radiation hazards that did not reflect official (e.g. BEIR) doctrines. This control of technical journals has been the key to successful suppression of the truth about the hazards of low level ionizing radiation over the past 20 years or more.

If might be argued that this suppression of the truth was "for the good of science" in that it has saved the jobs of thousands of weapons technologists, engineers, scientists, radiologists, and other AAAS members whose livelihood depended on radiation technolgy. It has, in this view, hurt only a handful of health scientists. This is the risk-benefit picture from the Big Science point of view. From my point of view, the suppression of the information of hazards has led to profligate use of radiation technology. For instance, almost everyone in the United States has been exposed to dosages of x-ray which were entirely unnecessary. This produced a non-negligible and completely avoidable risk of leukemia and other diseease. The price of suppression is therefore tens of thousands of unnecessary deaths , millions of avoidable episodes of diceases (e.g., allergies), and a legacy of genetic damage that will plague the human race for generations to come.

Courier-Express
ESTABLISHED 1834 Buffalo Family Owned and Operated ESTABLISHED 1846

Washington Merry-Go-Round December 3rd

Radiation Hazards Suppressed

By JACK ANDERSON and LES WHITTEN

WASHINGTON — In a deadly attempt at censorship, the federal government has systematically suppressed disagreeable news about the danger of radiation from nuclear power plants. It almost looks as if the federal authorities are more anxious to protect the nuclear industry than the public health.

Dr. Bross

They have hushed up evidence, for example, that low levels of radiation may cause cancer. The risk exists, according to suppressed studies, at radiation levels that government agencies now accept as safe. Here are some case histories we have uncovered:

CASE HISTORY NO. 1—World-renowned Dr. Karl Z. Morgan, director of health physics at the Oak Ridge, Tenn., nuclear works for 30 years, conducted research into the possible health hazards of certain plutonium breeder reactors. He finally became convinced that the technology was not sufficiently safe.

In 1971, he prepared his findings for delivery at a symposium in Nuremberg, West Germany. En route, he stopped off in Switzerland for a brief vacation. He found an urgent message at the Zurich airport as he was about to board the plane for Nuremberg. American officials, he was told, were searching for him frantically.

DR. MORGAN IMMEDIATELY put through a call to the deputy director of the Oak Ridge laboratories. The distinguished researcher was informed that his paper, which had previously been approved, was no longer suitable for presentation.

Copies of the report had also been sent ahead to Nuremberg. The Oak Ridge officials asked the West Germans to destroy the 200 copies. These were replaced with 200 copies of an edited version, with all references to the fast breeder reactor deleted. Dr. Morgan, celebrated as the "father of health physics," is now at the Georgia Institute of Technology.

CASE HISTORY NO. 2 — Back in 1963, the Atomic Energy Commission sought to refute reports that low-level radiation could cause cancer and leukemia. Two government scientists, Drs. John Gofman and Arthur Tamplin of the Lawrence Lab in Livermore, Calif., were assigned to the project.

They readied a report in 1969 warning that for every unit increase of radiation, there would be 20 times the incidence of cancer. This was far above what the authorities had anticipated.

LAWRENCE LAB OFFICIALS moved immediately to censor the report. Twelve of Tamplin's staff researchers were removed from his jurisdiction. Later, after six years of research, Dr. Gofman was given a choice: Either he must terminate his project, or the commission would cut the lab's funds by a quarter of a million dollars. That ended the research.

Dr. Gofman is now conducting independent research at Berkeley.

CASE HISTORY NO. 3 — Dr. Irwin Bross, working under a research grant from the National Cancer Institute, reached conclusions similar to those of Gofman and Tamplin. Among the offspring of parents previously exposed to X-rays, Dr. Bross found a small percentage show genetic damage.

In the summer of 1976, he presented his findings to reviewers at the National Cancer Institute. He immediately came under intense fire, and his grant from the government to continue his research was not renewed. He also found it impossible to publish his conclusions in government journals.

Finally, the Journal of the American Medical Assn. published a small part of Bross' findings. He is continuing his research, meanwhile, at the Roswell Park Memorial Cancer Institute in Buffalo, N.Y.

CASE HISTORY NO. 4 — Dr. Thomas F. Mancuso of the University of Pittsburgh spent a decade developing data, which linked low-level radiation exposure to cancer among workers at the Hanford Atomic Works in Washington state.

But earlier, when the results appeared negative, he came under pressure from the Energy Research and Development Administration to publish his findings prematurely. Dr. Mancuso resisted the pressure and went on to produce results the government didn't like.

IN 1974, ERDA's Dr. James Liverman suddenly decided to terminate the project at Pittsburgh and transfer it to the Oak Ridge-associated universities.

The transfer of the project to the government's facility at Oak Ridge, in the words of one scientist, was tantamount to "hiring a fox to guard some chickens."

In all these studies, cancer danger was found in radiation dosages far below dosages the government allows.

Footnote: We were still awaiting comment from government spokesmen when we went to press.

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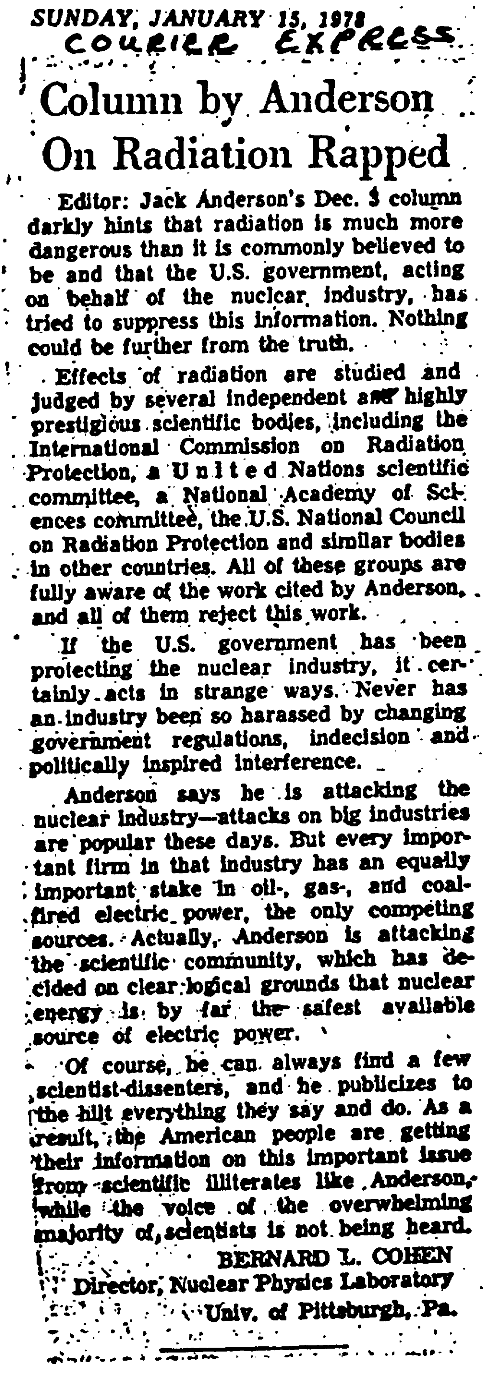

SUNDAY, JANUARY 15, 1978

COURIER EXPRESS

Column by Anderson On Radiation Rapped

Editor: Jack Anderson's Dec. 3 column darkly hints that radiation is much more dangerous than it is commonly believed to be and that the U.S. government, acting on behalf of the nuclear industry, has tried to suppress this information. Nothing could be further from the truth.

Effects of radiation are studied and judged by several independent and highly prestigious scientific bodies, including the International Commission on Radiation Protection, a United Nations scientific committee, a National Academy of Sciences committee, the U.S. National Council on Radiation Protection and similar bodies in other countries. All of these groups are fully aware of the work cited by Anderson, and all of them reject this work.

If the U.S. government has been protecting the nuclear industry, it certainly acts in strange ways. Never has an industry been so harassed by changing government regulations, indecision and politically inspired interference.

Anderson says he is attacking the nuclear industry—attacks on big industries are popular these days. But every important firm in that industry has an equally important stake in oil-, gas-, and coal-fired electric power, the only competing sources. Actually, Anderson is attacking the scientific community, which has decided on clear logical grounds that nuclear energy is by far the safest available source of electric power.

Of course, he can always find a few scientist-dissenters, and he publicizes to the hilt everything they say and do. As a result, the American people are getting their information on this important issue from scientific illiterates like Anderson, while the voice of the overwhelming majority of scientists is not being heard.

BERNARD L. COHEN
Director, Nuclear Physics Laboratory
Univ. of Pittsburgh, Pa.

Roswell Park Memorial Institute
Buffalo, New York 14263

December 1, 1977

Dr. Lauriston Taylor
National Council on Radiation
  and Protection
7910 Woodmont Avenue
Bethesda, Maryland

Dear Dr. Taylor:

As your fellow discussant (along with Dr. Karl Morgan) on the MacNeil-Lehrer Report on public television, I was disturbed by your concluding remarks (for which there could be no reply) denying the validity of the scientific research that Dr. Thomas Mancuso and I have been carrying out on the hazards of low-level ionizing radiation. In your derogatory comments you claimed to speak in the name of the 'radiation protection community" and and unnamed but allegedly outstanding scientists. Under the Freedom of Information Act I am asking you (and the NCRP) to identify the persons and to provide copies of the critiques that were the basis for the negative comments that you made about our work. In my view, the public has the right to know the identities of the individuals so as to be able to judge their competence and possible conflict of interest. This information would, I believe, allow non-experts to judge whether this public attack on the scientific reputation of Dr. Mancuso and myself was warranted.

Two points might be made. First, the NCRP is the recipient of federal funds which bring it under the Freedom of Information Act. Second, the usual defense of anonymous peer review (i.e., that it is for internal use by an organization) does not apply when it is the basis for public disparagement of the work of scientists on national television.

There is a certain irony that a TV program whose theme concerned the use of peer review processes to attack the findings (and the funding) of those of us who have come up with positive findings on low-level radiation hazards should end with an example of this kind of attack from ambush. During this program I had pointed out that I was not getting peer review from my peers in epidemiology and biostatistics. Moreover you had specifically denied expertise in these areas. So it will be very interesting to see just who and what provided the basis for your very negative assertions about our research. Remember, I am not just asking, I am asking under the Freedom of Information Act.

Very sincerely yours,

Irwin D.J. Bross, Ph.D.
Director of Biostatistics

IDJB/mak
CC: MacNeil-Lehrer
    Robert Alvarez
    Dr. Thomas Mancuso

LAURISTON S. TAYLOR
RADIOLOGICAL PHYSICS CONSULTANT
7407 DENTON ROAD
BETHESDA, MARYLAND 20014
CODE 301-652-5096

December 16, 1977

Irwin D.J. Bross
Director of Biostatistics
~~Roswell Park Memorial Institute~~
Buffalo, New York 14268

Dear Dr. Bross:

Your letter of December 1, 1977 addressed to me at the NCRP has been forwarded to me, since I no longer hold any operating position in that organization.

I'm sorry if you felt that any of my remarks were intentionally derogatory. I simply felt that I was essentially echoing the general feelings and attitudes which I hear among most of my colleagues and was not pretending to be speaking in the name of or for any of them.

There is no documentary information that I am aware of within the NCRP relative to the criticisms to which I referred during the program. These have, however, been the subject of many conversations. Actually it is my opinion that the gist of criticisms which I mentioned are already in the open literature or aleast have been presented at open technical meetings.

You are in error with regard to the position of the NCRP under "The Freedom of Information Act." The NCRP is not a government organization and the Supreme Court has already ruled that organizations such as the NCRP do not fall under the act. Secondly, the NCRP is not engaged in any "peer review" of your work or that of Dr. Mancuso. Individuals may have examined them in depth but the NCRP, as such, has not done so.

I hold myself totally without responsibility for the subject-matter and intentions of the television program. I had no idea in advance that it would be primarily devoted to discussing the "peer review" problem which seems to worry you. Had I known this I would surely have taken no part in it. In accordance with the discussions that I had had with a representative of the station the day before, I had expected that my comments would have been primarily devoted to discussions of some of the problems on the medical uses of ionizing radiation. Furthermore I had no idea of the direction in which the program would go, even after having seen a number of the questions which might be asked and which were shown me within the two or three minutes preceding the actual taping. You see I was not on that program to defend or attack you or anybody else, and I simply answered the questions and comments as best I could at the time.

Sincerely yours,

Lauriston S. Taylor

LST/dkb

ROSWELL PARK MEMORIAL INSTITUTE

Buffalo, New York 14263

January 18, 1978

Michael Parsont
Environmental Standards Branch
Office of Standards Development
United States Nuclear
  Regulatory Commission
Washington, D.C. 20555

Dear Dr. Parsont:

On January 16, 1978 I received your letter dated January 12, 1978 and Dr. Rothman's letter dated January 5, 1978 in which you have made receipt of my "presentation" a precondition for setting a date for the meeting.

I now have letters from you, Dr. Kastner and Mr. R.B. Minogue of the Nuclear Regulatory Commission mentioning a meeting date at the end of January or the beginning of February. However, your letter fixes the date at 10 weeks from the "date of receipt of your presentation by me" (say, Monday, January 23, 1978) which would seem to put the hearing at the beginning of April. I won't try to hold the NRC to the dates that were originally mentioned since they were unrealistic. I don't understand why they were mentioned in the first place.

As I informed you in response to your telephone call of January 17, 1977, I have given in to your pressure and I am enclosing the current draft of my presentation (the slides for which you already have). I do this, although I don't want to, so as to avoid protracted negotiations that would delay the open meeting indefinitely. However, for you to hold the date of the meeting "hostage" until my presentation was sent in as "ransom" automatically puts us in an adversary relationship. And just in case my capitulation to pressure here gives you any new ideas, let me note that I was in a strategic position to get my way in this matter. The NRC has made a clear public commitment to me on this meeting. It is being watched by congress, the executive, and the public. The commitment is to the presentation of our findings and not to the review by Dr. Rothman or anyone else. This is the last time that I will permit either you or Dr. Rothman to unilaterally impose conditions or restrictions on my presentation or on the arrangements for this meeting.

Dr. Rothman states: "The purpose of my review, as I see it, is not to contest Dr. Bross' findings but to comment on them intelligently and critically." Now that the full text is available, it will be obvious that the slides which I previously sent contained all of the information which Dr. Rothman required for this purpose. The slides present solid factual evidence that exposures in the one rad range (i.e. within the permissible NRC 5 rem level) seriously increase the risk of leukemia in the person exposed (or the children of the person). There is a quantitative conclusion that the risk is about doubled. This finding calls for something more than clever commentary. If the public is to benefit from Dr. Rothman's critique, he has to affirm or deny this conclusion. The standard academic gimmicks that sound impressive but evade this choice serve only to protect the speaker and not the public.

From my standpoint as a concerned health bureaucrat, it is not going to be enough for me to prove the point that there are these serious risks. To protect any nuclear workers from radiation hazards, the NRC must take action to cut the permissible level. The basic difficulty here is that the issue is a public health issue but the NRC is a technology-oriented not a health-oriented agency. Practically all of its activities and competences involve technological compliance and not health decisions. Hence action on nuclear radiation hazards, like action on tobacco hazards, have been based on entirely different procedures and standards than, say, action on the chemical carcinogens regulated by the FDA. For instance, the FDA uses the Delaney Amendment. This fail-safe rule is a good illustration of what I have called the "Primacy Principle" (the principle that with potentially hazardous technology, the benefit of the doubt must go to the public and not to the technology). The protection of the public health should override the "grandfather" clauses that protect some carcinogens. Therefore in my presentation I have discussed the strategic issue of guidelines for action on public health hazards as well as the tactical issue that there is a serious hazard.

Although I will be speaking to the NRC at this meeting, what I will have to say is directed to the general public that will be the final judge on this issue. I am not interested in a clever dialogue with academicians, members of the radiation protection community, or persons who are or think they are scientists. My job is to present the facts about radiation hazards to the public in a way that the public can understand and can make sound judgments. The clearest way to present the facts is in an "adversary science" format. In these confusing issues, the public is at least able to tell who is arguing on what side. If Dr. Rothman should happen to agree with our finding of serious risks in the one rad range (and be willing to say so clearly), then there can't be this format. But if he doesn't want to agree with the main points (whatever the agreement or disagreement of side issues) then there is automatically an adversary science situation.

Having been involved in public health "controversies", mostly ones that have been manufactured to protect some vested interest, I know that there are all sorts of linguistic gimmicks where a speaker seems to take what sounds like a strong negative position (in the public view) while actually taking no definite position at all (e.g., "a creditable effort but one that is not entirely convincing"). The "adversary science" format can help to avoid this mushiness, a non-scientific put down of a scientific study. With the strong prima facie case that I have presented, a critic has to find some really serious error in the work in order to refute it. If the critic tries to get by with the cute language games (from my past experience, these are very popular), then it is my responsibility to try to make clear to the public what is going on.

Hopefully Dr. Rothman will see fit to agree with our principal conclusions. If not, no matter what the name "adversary science" suggests to him or to the NRC, this is the format we will be in. In terms of bringing out clearly whether disagreements are matters of style or matters of substance and of giving the public a basis for judging the issue, I see nothing wrong with calling a spade a spade. If the public understands this issue and demands adequate protection against the hazards of low level ionizing radiation, I will have accomplished my purpose. Whatever action, if any, NRC takes as a result of the hearing will not block eventual protective action. If the NRC continues to stall, delay, or otherwise obstruct action that would cut the permissible level from 5 rem to 0.5 rem per year, tactics evident in the arrangements for this meeting, then I believe congress will act to move the decision-making on this health issue to an agency that is better qualified to do the job.

Finally, since the full text of my presentation has been forced out by your direct pressure, I am sending it (and this letter) to Congressman Paul Rogers as back-up material for my testimony which is planned for January 24, 1978.

Very sincerely yours,

Irwin Bross

Irwin D.J. Bross, Ph.D.
Director of Biostatistics

IDJB/mak
Enc.

CC: Dr. Jacob Kastner
Mr. R.B. Minogue
Open

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

FEB 1 1978

Dr. Irwin D. J. Bross, Jr.
Roswell Park Memorial Institute
666 Elm Street
Buffalo, New York 14263

Dear Dr. Bross:

Thank you for sending me a copy of your January 18 letter to Dr. Parsont.

In reading your letter it is apparent that your interest goes beyond the issue of radiation-dose response for leukemia in children irradiated in utero, and in offspring following preconception irradiation of parents, to broader issues of occupational exposure. As a consequence, I want to comment on some areas which may not have been touched in previous correspondence between you and the staff.

Your comment that NRC is technologically oriented has an element of truth; the solution to many of the safety and public health issues with which we wrestle is found in improved engineering. But you should not let this fact lead you to conclude that we are not able to evaluate and make proper judgments in health-related matters. Fully one third of the Office of Standards Development professional staff have backgrounds and training in either health physics or the biological sciences. We have capable radiobiologists and persons with epidemiology expertise on the staff.

Our goal, as related to protection of occupationally exposed workers, is the reduction of actual radiation exposure levels to as far below the limits as is reasonably achievable (the so-called ALARA concept). This applies to both individual and total exposures in accordance with the basic radiological protection principle that no level of exposure is without some risk. The implementation and enforcement actions to reduce these actual doses do rely, in fact, on technological decisions and actions. Such actions are contained in our Regulatory Guides, some of which I am enclosing for your information. In addition, I have enclosed a recently issued proposed guide on reduction of occupational exposures of medical personnel which should be of particular interest to you, and we would appreciate your comments on it. You may not be aware that recent NRC staff estimates of the total radiation exposures of nuclear power industry employees and nuclear medicine employees are about the same--about 21,000 man-rem and 27,000 man-rem respectively (1975 data).

The exposure value for nuclear medicine employees is derived from a limited response (1179 out of 8200 NRC licensees comprising a population of about 96,000 employees) to an NRC staff survey on the total body radiation. If we assume the same dose distribution and exposure experience at the 8600 nuclear medicine facilities under control of Agreement States, the population exposure and number of employees would be about doubled. The population of commercial power reactor employees with measurable exposure was about 28,000 in 1975. An NRC document "NUREG 0419" will soon be published giving more detail on this survey.

In your letter you stress that the "permissible level", which you appear to regard as synonymous with the 5 rem per year dose "limit", should be reduced to 0.5 per year. As I said above, the most important aspect of NRC's approach to occupational exposures is not the upper limit but how well we apply the ALARA regulation in licensing actions to reduce actual exposures to well below the limits. Thus, as we apply the ALARA concept, permissible levels and dose limits are not synonymous. In fact, the actual average exposure of the principally exposed group of employees in the nuclear power industry has been maintained at about 0.7 rem per year. This is true in spite of increased activities in such areas as in-service inspections. This average 0.7 rem/year includes only those personnel with measurable exposures. If all monitored individuals were included, the average exposure would be about 0.3 rem per year. I am enclosing a copy of the "Ninth Occupational Radiation Exposure Report, 1976" which will give you our latest data on occupational exposures.

You also expressed interest in which governmental agencies have responsibilities for controlling radiation exposures. In the past, the Federal Radiation Council (FRC) provided overall guidance on exposure limits, including occupational exposures; the FRC authority now rests with the Environmental Protection Agency (EPA). There are many other government agencies including NRC which issue regulations for the control of occupational and other radiation exposures to implement this guidance for the specific activities which they regulate. For your information, I have attached a copy of a portion of Volume V of a study on federal regulation by the Senate Committee on Governmental Affairs (A. Ribicoff, Chairman). This study provides an excellent summary of this rather complex situation.

I have been informed that Dr. Parsont has set the open meeting date for April 7, 1978. I believe this meeting will be most informative and hope it can now go forward without further delays.

Sincerely,

Robert B Minogue

Robert B. Minogue, Director
Office of Standards Development

Enclosures:
See attached page

Dr. Irwin D. J. Bross, Jr.

Enclosures:
Regulatory Guide 8.8
Regulatory Guide 8.9
Regulatory Guide 8.10
Regulatory Guide 8.13
Regulatory Guide 8.18
NUREG - 0322
NINTH ANNUAL OCCUPATIONAL
RADIATION EXPOSURE REPORT, 1976
Vol. V Study on Federal Regulation pp.326-339

MINOGUE

Disavowed by Mr. Minogue of NRC

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

2-7-78
Copy to Mancuso Stewart & Kneale
Have Art do a cover note & also have him contact Bross re the letter

February 6, 1978

Anthony Z. Roisman, Esq.
Natural Resources Defense
Council, Inc.
917 - 15th Street, N.W.
Washington, D.C. 20005

Dear Tony:

My letter of January 23, 1978 transmitted to you a copy of the action plan submitted to the Commission by the Staff with respect to your rulemaking petition on occupational radiation dose limits. Since then, Dr. Brodsky, one of the four members of the NRC Staff team evaluating the Mancuso report, has completed and publicly distributed his analysis of the report. A copy of Dr. Brodsky's memorandum on the subject, dated January 12, 1978, has been placed in the record of the rulemaking proceeding in the Public Document Room. I am enclosing a copy for your convenience.

You will recall that the action plan contemplated that the Staff would finish its technical review early in 1978. Staff now reports that the public meeting with Dr. Bross can be held no earlier than April of 1978 because of Dr. Bross' lack of cooperation by failing to fully reveal his data to Dr. Rothman. Dr. Rothman is an Associate Professor of Epidemiology at Harvard University who has been retained by the Staff as an expert consultant to analyze the Bross data. He is expected to participate in the public meeting with Dr. Bross. This meeting will produce a meaningful scientific discussion only if all the participants cooperate fully. If you are in contact with Dr. Bross, I would appreciate your discussing his participation with him.

Sincerely,

James L. Kelley
Deputy General Counsel

Enclosure as stated

Mr. ROGERS. Thank you very much, Doctor.

What is the tristate survey?

Dr. BROSS. The tristate survey is a somewhat famous body of data which was the brainchild of Dr. Abraham Lilienfield who conceived and set up and very lárgely influenced this study and its design. Its design was 20 to 30 years ahead of its time. It was done around 1960; I was involved in a minor way as a statistical adviser at that time, but Dr. Lilienfeld gets all the credit for this fine study. He has, of course, help from Dr. Levin and Dr. Schulman and Dr. Graham and others, but I mean——

Mr. ROGERS. Who was that?

Dr. BROSS. I'm Sorry. There was help form other doctors in this work, but I credit Dr. Lilienfeld with this important study.

Now, the way it works is really quite simple. There were three sample areas in three different States, New York State, Maryland, and Minnesota. I should say that this was chosen with very careful scientific considerations, but concidentally it happened to be the home States of the doctors who were cooperating in this study. And the effort was made to get all cases of leukemia in these sample areas for the 3-year period, all cases of leukemia that occurred.

So the population base I am talking about is a total population in those States, the areas of those States. That is where the 13 million comes from.

Mr. ROGERS. 13 million?

Dr. BROSS. 13 million persons, sir.

Mr. ROGERS. Thank you.

Dr. BROSS. They tried to find all of the cases of leukemia—they attempted to get them. You never get perfect data, but they were very hardworking, I can testify. Then they sent interviewers out to be households to interview about the exposure. It is a very long schedule. I took anywhere from one-half hour at the very shortest to 1½ hours, sometimes longer. It is a very detailed schedule on a great many different items, not just radiation, but a lot of items.

Then a stratified random sample was also drawn—I can speak to that because I was the person responsible for that part of the operation—which represents the population, the 13 million persons, in that area. It is as close to an unbiased sample as we can get. There are very few epidemiological studies, even now, that have anything like this quality.

For instance, as another precaution, they sent the interviewers out without telling them whether they were going to a household where there had been a leukemia case, or whether a random sample individual had been chosen. The interview was conducted in such a way that the key questions came at the very end so that the interviewers would not know that these might be leukemias, even if they were guessing. And, of course, they were not supposed to guess. Yes, sir?

Mr. ROGERS. Has the information that was gathered now been analyzed and have any conclusions been drawn?

Dr. BROSS. There has been a whole series of studies coming out of this work. They started shortly after completion with very preliminary reports, and they continued—we are not the only persons who published from this data. There is a whole series of papers published by Dr. Lilienfeld, Dr. Graham and others. I inherited this data around the end of the 1960's because the department of biostatistics was intact at RPMI but the department of edipemiology kind of fell apart, and I became acting head of epidemiology. This material came into my domain and I felt it was important and it had not been fully analyzed and there was still much we could learn from it, and we have learned a lot since then.

But it would emphasize that we are not the only persons who have worked with the tristate data. It has been published. There have not been, I think, too many complaints about this point in the past, and our latest studies were just published. We have also published on this a series of papers, maybe four or five in all—maybe even more—not dealing just with radiation but with things like exposure to sick cats, and so forth.

So this data has been analyzed several times, but not to the depth, I believe, to which we subjected it.

Mr. ROGERS. And your conclusion, after studying the data, as regards low-level radiation is?

Dr. BROSS. There are really two sets of conclusions, one dealing with the adults in the study, really what I am giving as the doubling dose, for instance, is technically the males in the study who had nonlymphatic leukumia, adults. That is the basis of the analysis for the doubling dose.

But we have also analyzed the data on the children, which is very important. We are concerned about exposure to radiation reported during pregnancy—I might just say that the whole reason for the tristate study was the work of Dr. Stewart. An important stimulus was to really confirm or deny this work. So, in a way, it all links up.

But in the children, we find that whether the radiation is delivered to the mother during pregnancy—and, of course, to the fetus—or to the mother prior to pregnancy or to the father prior to pregnancy, there is an increased risk of leukemia, and it is a substantial increased risk. And it is not quite identical in all three cases, but it is high in all three cases, by our standards.

To give a little preliminary estimate of what this means, I would say that approximately 1 percent of persons exposed to the radiation are affected. So everybody does not get affected by this radiation, just a very small group.

But the ones who are affected by the radiation are very much affected and it shows up by an increased risk of leukemia that might be 30, 40, or 50 times the normal risk, an enormous increase in risk, in the affected group, just a very small proportion of the population.

And not just leukemia—and this is really the key to our analysis—but other childhood diseases have a strikingly increased risk. And we have reported this over the years in a series of papers starting around 1972. It was really our attempt to go deeper and deeper if we could, to try to explain what was happening here, that has led us to our curent results and the methodology we are now using, which is quite different from what we started, which was more traditional in the old days.

Now, that is for children. Now, for the adults, we find that instead of just 1 percent, maybe 5 percent are affected by the radiation, but still not the bulk of the persons exposed, and these persons do not have quite as high a risk of leukemia, maybe just 10 times the risk of leukemia, but we are looking at the adults in other risks, and their seems to be increased risks of diseases which are called heart diseases, which is not a entirely clear-cut category, but which seem to be related to the radiation, too. And by using this point, exploiting this point, we have those estimates which indicate a doubling dose way down in the range where most of the radiation is given.

Mr. ROGERS. I recall Dr. Stewart's saying that the overall doubling dose was about 33 rads.

Dr. BROSS. Yes, sir. She was giving you the doubling dose for all cancer. She also gave you the doubling dose for multiple myeloma, for instance, which she gave as 3.6, which you see, is not so far from our estimate of 3 to 5. These are completely independent.

Mr. ROGERS. For leukemia.

Dr. BROSS. For Leukemia. But, as I indicated in my correction in the testimony, I did not want to give the misimpression, as my testimony might have given, that we are talking about exactly the same thing. But it is certainly true that inside that range you are getting doubling doses of some diseases.

Mr. ROGERS. Now, is there any point in that range where the risk is not doubling?

Dr. BROSS. Well, I really, I am not sure exactly what the thrust of this question is, but let me try it, and if I do not get the thrust, you can tell me.

We are talking about persons who are exposed down in this 1 rad range, and we are talkng about, say, a dosage response curve in that range. We have the first dosage response curve for adults that has ever been done in this range. And the appearance of the curve is such that it does not look too straight. If the theory is a straight line and that is what is used in extrapolation, that is probably why the extrapolations are wrong.

In theory you should go up doubling each time so you get 2 to a power, but I think that that is probably not true in practice.

Mr. ROGERS. Well, we really have not yet determined the threshold point where you would not double?

Dr. BROSS. Oh, if the question involves threshold, that is a different question, as I would see it. There is no threshold. One thing which the dosage response curve that I mentioned clearly lays to rest, I hope, once and for all, is the notion that there is a threshold for low-level radiation effects. There is no threshold.

We cannot be certain whether, from our data, you can just about fit a straight line in the short range that we are looking at, so we cannot absolutely flatly reject the linear hypothesis. But if anything, it is going in the absolutely opposite direction, and that is why we were underestimating the risks so badly. It is turning out the wrong way, from the pulic health standpoint.

Mr. ROGERS. What would you recommend as an occupational standard for exposure to radiation which would provide an acceptable risk?

Dr. BROSS. Well, I think since I have been in public health for many years, I would rather get something accomplished than to ask for the moon and get nothing accomplished. I think it is certainly feasible now to ask that the maximum permissible dose per year by the NRC, or any other agency, Federal agency, should be no more than 0.5 of a rad.

I did not originate this, it has been proposed for years, it has been fought for years, but now we have very solid evidence that that should be done.

Now, the evidence also coming from the NRC and others is that, in fact, it is a feasible level. They actually operate, exception a dirty installation, at or below this level. So it is just to protect a few dirty installations, really. I come from Buffalo and West Valley which, when it was operating was a very dirty installation. They were burning people out with a full dose of nuclear radiation and then firing them. Protecting workers in those kinds of installations, in reprocessing, is much harder than in power. One thing could be done, as far as I am concerned, overnight. I would strongly suggest that the Nuclear Regulatory Commission not wait to formally change this beofre they make a clarifying statement which came up at the Friday hearing. They should make it clear to the public that the "permissible" level is not necessarily a "safe" level. But when you say the Federal Government permits 5 rads, it automatically implies to most people that it has to be safe.

Mr. ROGERS. What about the standard for the general population?

Dr. BROSS. Well, I think that this is somewhat proportional, you know. If you cut one, then in general, you would try to cut the other, too. I would only say on this—and this is a personal opinion; it is apart from my testimony—that I do not believe that fence doses protect anyway, because it does not come out, as it were, uniformly around the fence. It comes out in chunks here and there where you may get very high concentrations a long way from a fence.

Mr. ROGERS. Two other quick questions.

Is there any way to identify that 1 percent of the population which will run a fiftyfold to a hundredfold risk of cancer?

Dr. BROSS. Could I keep that at fiftyfold, sir, because that is what our actual——

Mr. ROGERS. Excuse me.

Dr. BROSS. Fiftyfold, I would rather——

Mr. ROGERS. All right. Fiftyfold.

Dr. BROSS. The answer to that is yes and no. I am sorry to equivocate, but it is a difficult question. In a probability sense, the answer is yes. That is to say—for instance, in the children, there are certain conditions, asthma, hayfever, which are indicators that this individual is sort of perhaps likely to get leukemia, especially if the child is further exposed.

Now, these are not certain indicators. There are going to be a great many children who have these conditions who are never going to get leukemia. But, in the sense that we have a group that is enriched, has a higher probability of getting leukemia, yes we can do that both for children and for adults to some extent.

Mr. ROGERS. What studies are currently in progress in your program?

Dr. BROSS. Well, my focus at the moment because we are in a phaseout year, was to shutdown the studies other than the radiation studies so we could just concentrate all of our resources in doing all we could to get the out findings on radiation, I do not want to leave this incomplete, if I can help it. I think we may have to, but it will be as complete as I can manage.

But what we are doing, or before this point in time, our studies included studies of occupational health, cancer risks, and in fact, that is where the cosmetologists came in. And our studies—or this was what we were also proposing to do some studies of the etiology of breast cancer involving a question of what may actually trigger a cancer rather than just what sets the first step in motion, because we have evidence now from our studies that the cancer, or tumor cell, may grow to a certain small size and stop, then something else happens to make the cells go into a malignant state. If this change doesn't occur, the cells may stay benign for a while.

Mr. ROGERS. Thank you very much, Doctor.

Dr. Carter?

Mr. CARTER. Thank you, Mr. Chairman.

Dr. Bross, I want to commend you for an excellent and fearless report.

I understand that you have criticized the peer review process of the National Cancer Institute. Is there an alternative review process which you would recommend in order to achieve the kind of objectivity in scientific evaluation which we all recognize is needed?

Dr. BROSS. I think that the process of peer review should not be, as it were, an exclusive process, or the only process used. Rather most of the decisions could be made, essentially bypassing peer review and using, for the decisionmaking, just the performance, the track record, of persons reviewed. Now that obviously is not going to work for first grant applications, which really need a special process, because peer review is basically hostile to early work anyway. So they should be completely separated off anyhow.

But for most of the persons who are in science, say supported by NCI—I will speak to that, because I know more about NCI's operations—I would say, you know, they have been in the game for quite awhile and they have a track record. This track record is an objective measure of performance.

For instance, a certain number of publications. Now publications are not enough, necessarily, automatically in themselves. But our project, for instance, our program has produced 100 publications in about 4 years, which I think is a very outstanding productivity. This was disregarded entirely in our peer review.

So there are things: You can name your accomplishments and they can be verified. You can say we found this and that. It is either true or false. It can be checked.

In other words, you can go back and evaluate performance much easier than you can predict what somebody is going to do in the next 5 years. It is just easier to go back and get an estimate.

So there are objective ways. While there will still be balanced decisions where you would, perhaps, want to call peer review process into use, where these decisions came up—they would be intermediate positions. That is to say some programs have such a good track record they should be continued. And there would be other programs where there is just no track record at all and they should be terminated, or their proposal just should not be accepted.

But there might just be a middle group where there might be questions. There you might want to send out peer review to make the final decisions. But I think it is a matter of using, as much as possible, objective measures, which exist.

Mr. **Carter**. If they do not really like your findings, by what processes does the granting group refuse you further money? How do they go about this?

I believe you said there were three ways.

Dr. **Bross**. Well, I referred to three different disincentives, one being the blocking publication, the other being the attack on individuals, but those are not involved. I did not mention three different kinds in the peer review. The third thing was——

Mr. **Carter**. So you are referring to the disincentives for research?

Dr. **Bross**. Right.

But those are not part of the NCI's process.

Mr. **Carter**. Who does the suppressing or blocking of publications?

Dr. **Bross**. That is done basically with journals.

Mr. **Carter**. Yes, sir. And who is involved in this gossip which you mentioned?

Dr. **Bross**. I gave some examples. I think that the persons—I might say I do not consider myself as particularly the specific target in the past. I have not been hurt all that much, because I can take care of myself, to some extent.

Mr. **Carter**. But where are the sources?

Dr. **Bross**. But the persons who were involved in the scurrilous gossip in the past, generally speaking had got their resources and funding from like DOE, or it is ERDA or AEC.

Mr. **Carter**. Are they part of the establishment, then?

Dr. **Bross**. Yes.

Mr. **Carter**. You mentioned DOE.

After first blocking publication and engaging in scurrilous gossip, then they use the disincentive of peer review. How is this done?

Dr. **Bross**. Well, peer review can be involved in both of the other processes to some extent, but the review of the grant mechanism—the further funding mechanism of peer review would be the third item.

Mr. **Carter**. This is what you mentioned?

Dr. **Bross**. Yes.

Mr. **Carter**. Thank you.

Do you think that 3 to 5 rads is the doubling dose, then?

Dr. **Bross**. Yes, sir.

Mr. **Carter**. All right.

So with the incidence of leukemia at 3 to 5 rads, you found twice as many cases as you ordinarily would?

Dr. **Bross**. Yes; the persons exposed to this amount of radiation would have double the risk of leukemia.

Mr. **Carter**. And you think it is due to a break in the DNA chain, is that correct?

Dr. **Bross**. Yes, sir.

Mr. **Carter**. Does this affect the formation of certain protective enzymes?

Dr. BROSS. Well, you see, the DNA has all of the coding information for the whole organism.

Mr. CARTER. Yes, sir.

Dr. BROSS. And when you break the structure, you put misinformation into this and then you say lose the enzyme or it is ineffectively produced, or something, and this is part of a—it is not a single cause and event chain, it is a system. When you interfere with the operation of a system by losing a piece here, it makes that system less effective.

And so, it say, loses the ability to shut off the production of white blood cells.

Mr. CARTER. How many rads are used in a mammogram?

Dr. BROSS. Well, that depends on the year, in a way, because it has come down. Originally, the HIP studies were giving approximately 5 rads or 6 rads.

Mr. CARTER. Five rads? That is 10 times as much radiation as the maximum dose you recommend for any individual per year; is that correct?

Dr. BROSS. Yes.

Mr. CARTER. All right.

Dr. BROSS. But I should say quickly that that has been coming down with improved equipment and technology.

Mr. CARTER. Yes, sir.

Dr. BROSS. So that probably 2 rads is a better level now, or maybe even some people are doing 1 rad effectively.

Mr. CARTER. If women have had 10 or 15 mammograms what is going to be the incidence of leukemia or other forms of cancer in those women? 2^{10}?

Dr. BROSS. Well, as I say, if you went by straight theory——

Mr. CARTER. A function of that?

Dr. BROSS. I do not personally hold to this going up at quite that rate, but it is certainly going to be very substantially increased, many times increased, is what I would say, because I do not think we know exactly what the effect would be.

Mr. CARTER. Well, would we expect to see this effect expressed in the form of mammary cancer, leukemia, or some other form of cancer?

Dr. BROSS. Well, it can be—mammary cancer, because, of course, it is directed at this tissue, primarily, but I believe that both leukemia and lung cancer are items which will be coming up in this group and it is the same with thyroid. You get extra thyroid cancer, but in the groups that get this, there is also elevated risk of other cancers.

Mr. CARTER. Yes; there would be an increased risk of thyroid cancer, too.

At the present time, has there been any system established by those who conducted the mammogram program to followup on those patients who received X-rays? It seems to me that we should have kept careful records and that we should be following the health history of these women carefully.

Dr. BROSS. This program is still going on and, I might say, perhaps the worst feature of the program is that this mammogram is annual in many cases. That is to say, the persons are not just getting it once.

Mr. **Carter.** Over the years, we have exposed many people to X-rays of one source or another.

Dr. **Bross.** All of these people are being followed now.

Mr. **Carter.** Yes; radium dial painters, X-ray machine technicians, soldiers exposed to atomic bombs, and so on. It seems to me that, if they are exposed, we could keep records of their exposure and follow what happens to them.

Dr. **Bross.** I certainly agree. In this case, the study is ongoing.

Mr. **Carter.** What about the effects of X-radiation?

Do you have knowledge of premature aging in those who are exposed to X-radiation?

Dr. **Bross.** Well, I think this is a kind of summary statement of the overall effect. What you are really saying here is that the persons who are exposed to radiation have risks of persons who are at an older age than they actually are chronologically. So if you increase the risks, say, of leukemia, you are essentially moving—that is the equivalent of making the person older, and if it is true, for a number of chronic diseases, you see, then the effect is very much like aging.

Now, whether you want to call it exactly aging, that is another question, but the risks are like aging——

Mr. **Carter.** I notice that radiologists now protect themselves quite carefully in most cases. There are all sorts of protective mechanisms which have reduced the incidence of leukemia greatly among their groups.

In 1969, I believe the incidence of leukemia was 2½ times normal in their group, and since that time, it has been normal—that is, the same as for other groups. I believe that is correct.

Have you noticed an increase in osteoperosis in exposures to X-ray or overexposures or X-ray therapy?

Dr. **Bross.** I have to explain that the tristate survey, as I have indicated, is limited to leukemia and the other diseases are not studied except by a question schedule given to patients to find out past diseases. So, in other words, the focus is on this disease, so we do not have, as it were, a focus on each of the other possibilities from this kind of data.

Mr. **Carter.** I see.

Well, I have watched some of these things very closely in the past few years.

What about multiple myeloma? Have you seen an increase, or do you have records of, an increase in multiple myeloma?

Dr. **Bross.** No. You see, this is somewhat focused, when you get your data records, you take a sample just of leukemias. You do not get the others, unless coincidentally.

Mr. **Carter.** So, you have studied especially leukemias.

Dr. **Bross.** Yes, sir.

Mr. **Carter.** What type of leukemias are caused by X-rays?

Dr. **Bross.** Well, in the children, it would be the lymphatics, but——

Mr. **Carter.** Sir?

Dr. **Bross.** It would be the lymphatic leukemias, in the most part, in the children.

Mr. **Carter.** Are they difficult to differentiate?

Dr. **Bross**. Oh, very. It is very difficult. I am not a physician and I have worked with people who are experts in this area and I get kind of confused.

Mr. **Carter**. Since you are a statistician, I want to ask you another question. There were some 2,235 men who wore film badges at the atomic blast, "Smoky" on August 31, 1957. They were exposed to that blast.

Of that number, 447 have been checked by the Center for Disease Control at the present time and 8 of them have leukemia. Would you say that this figure is statistically significant?

Dr. **Bross**. Yes.

Mr. **Carter**. It would mean, then, that some of the leukemia was a result of exposure to radiation?

Dr. **Bross**. That's right.

Mr. **Carter**. Thank you very kindly, Doctor, for an excellent presentation.

Mr. **Rogers**. Doctor, let me just ask quickly about the disapproval of your grant.

Dr. **Bross**. Yes, sir.

Mr. **Rogers**. How much was the project costing NCI per year?

Dr. **Bross**. About $250,000 to $300,000.

Mr. **Rogers**. And when was the project supposed to terminate?

Dr. **Bross**. Well, this is the sort of thing which is renewable.

Mr. **Rogers**. So it would have continued until you finished your research?

Dr. **Bross**. Yes.

Mr. **Rogers**. Now, when will it terminate?

Dr. **Bross**. Actually, the kind of grant that I was working on was called a core grant, which was a grant—or was called a core grant—to the department, and it was in cancer research and epidemiology.

Mr. **Rogers**. When will the project terminate now?

Dr. **Bross**. In August of this year.

Mr. **Rogers**. Of this year.

Are there any alternative sources of funding?

Dr. **Bross**. Not in sight.

Mr. **Rogers**. Do you think that disapproval represented covert, planned agency action; the opinions of a few hostile reviewers who just happened to all wind up on the review panel; the fear that your findings will mandate lower standards, or what?

Dr. **Bross**. Well, I think the problem that we faced here was that we were being reviewed, not by our usual group, which would be more epidemiologists, but by a clinical panel, a clinical group, representing the parent committee. And also, it was a clinical panel that was site visiting us. We did have epidemiologists and statisticians on it, but it was still clinically oriented.

Now, this is a very unfavorable group to go to for any preventive medicine or primary prevention program. The doctors are not really all that interested in primary prevention.

So our work was put into this kind of a review group for review, was maybe where we——

Mr. **Rogers**. Now, who made that judgment?

Dr. **Bross**. I do not know.

Mr. ROGERS. Was the decision made within the National Cancer Institute to change your review group?

Dr. BROSS. Well, I believe it was in conjunction with some sort of administrative procedure or something like this, that they were going to stop giving departmental core grants or calling them core grants or something like this. They were going to call them program project grants, and then they were going to have them reviewed by an entirely different body.

Mr. ROGERS. Rather than epidemiologists, they put clinicians on the review?

Dr. BROSS. Yes, sir. For the parent study group.

Mr. ROGERS. Now you had a site visit in February?

Dr. BROSS. Yes, sir.

Mr. ROGERS. Was this the same basic classification of people, clinicians, on this site visit?

Dr. BROSS. I would say that they were clinically oriented, but they included epidemiologists and the chairman was a statistician.

Mr. ROGERS. Do you know what the epidemiologists or the statistician recommended on the review panel?

Dr. BROSS. Well, the primary epidemiologist was Phil Cole and he was dealing with a specific—the breast cancer part of the program. So they divided up.

There were six projects, you see, and they sort of divided the committees up, and so the persons who were involved in the review of the three radiation grants were the ones who really dominated this meeting, and I do not think it is necessary in control of peer review to put everybody hostile on a committee. You do not need that. You just need to put one or two people who are really hostile, and they will give a tone to the whole review that would sort of finish it off.

Mr. ROGERS. Were these reviewers competent to judge your work?

Dr. BROSS. Well, I was reviewed by a person from M. D. Anderson, who is a radiologist, who is interested in mammography, but who had no experience or background whatever, so far as I know, in the areas that we were doing research. And he was the one who threw our schedule off and really led the charge.

So, I think that—there was really no review of the radiation grants other than by one person on the grant, the review panel, who was competent was Dr. Jablon. I think Dr. Jablon really was not the person who was the obnoxious person, at any rate. I do not think he came to our defense, but, on the other hand, he did not attack us. He was sort of neutral.

This is the basic situation on these reviews. Most people come in kind of wishy-washy, indifferent. If you put a couple of people really hard against, that carries the whole panel and you get a negative review.

Mr. ROGERS. I notice some mention of an angry radiologist.

Dr. BROSS. That is the doctor from M. D. Anderson. I am not really saying he should not be angry because it is only natural. Radiologists have blamed me for cutting the amount of radiology given in mammography by 40 percent, so they were pretty angry with me.

Mr. **Rogers**. Thank you so much, Doctor. We are grateful to you for giving us the benefit of your experience and we may be in touch with you further. Thank you for your presence.

Dr. **Bross**. Thank you, sir.

Mr. **Rogers**. Excuse me, I am sorry. Dr. Carter may have another question.

Mr. **Carter**. In looking over the so-called pink sheet review of your renewal application, I find that while your qualifications are given very favorable review, your junior staff is strongly criticized. Would you like to comment on any of these criticisms?

Dr. **Bross**. Well, I might say that this was the reason why I objected to making public the pink sheet, they were careful to be nice to me, and it was hypocritical, but it is safe—safer, anyway. They were extremely nasty to my junior staff.

Now, my junior staff are really good people, because I am kind of the idea man in this kind of arrangement. They do the work. If they were not really competent, I would not have anything here to show you or tell you about. They were good persons. They had lots of publications and they really got this very great disparagement from these persons.

These are really putdowns. They sound, to many people, like scientific statements.

For instance—I will give just one example. They said this person cannot even tell a difference between the situation when the X-ray is delivered during pregnancy or prior to pregnancy. That sort of indicated that the person had to be totally incompetent because, in point of fact, this individual and I had written a paper on this subject.

Mr. **Carter**. When did you hire these junior staff investigators? Were any of them working with you on the earlier projects which had received favorable review from the National Cancer Institute?

Dr. **Bross**. Many of the persons in this review have been with me for approximately 8 years of this grant. We did not have a lot of problems, you now, in the past. I cannot remember exactly when everyone came to the project, but the majority of the persons who were, in effect, the principal investigators on the six individual projects had been with me for at least 5 years.

Mr. **Carter**. And they were there when you received favorable reviews from NCI, is that correct?

Dr. **Bross**. Yes, sir, that is correct.

Mr. **Carter**. And when your reports began to show the risks of ionizing radiation, then the reviews became less favorable, particularly to your junior staff? Is that correct?

Dr. **Bross**. Yes, and particularly to those who were directly involved with the radiation.

Mr. **Carter**. Thank you very kindly.

Mr. **Rogers**. Thank you very much, Doctor. We appreciate your being here.

The next witness will be Dr. Arthur C. Upton, who is the Director of the National Cancer Institute.

Dr. Upton, we welcome you to the committee, and if you have colleagues whom you would like to join you, we would be pleased to have them—I believe they are Dr. David Joftes and Dr. Charles Land.

We welcome you to the committee. Your statement will be made a part of the record in full, and you may proceed as you desire. I might say at the beginning, Dr. Upton, we know you have not been at the helm of the NCI for a very long time here, so many of the matters we will discuss, the committee is cognizant of the fact that you were not at that time director.

STATEMENT OF ARTHUR C. UPTON, M.D., DIRECTOR, NATIONAL CANCER INSTITUTE, NATIONAL INSTITUTES OF HEALTH, PUBLIC HEALTH SERVICE, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, ACCOMPANIED BY DAVID L. JOFTES, PH. D., CHIEF, REVIEW AND REFERRAL BRANCH, DIVISION OF CANCER RESEARCH, RESOURCES AND CENTERS; AND CHARLES E. LAND, PH. D., STATISTICIAN HEALTH ENVIRONMENTAL EPIDEMIOLOGY BRANCH, DIVISION OF CANCER CAUSE AND PREVENTION

Dr. UPTON. Thank you, Mr. Chairman. I am honored to appear before you today to discuss the health hazards of low-level radiation as they relate to cancer and to present activities of the National Cancer Institute in this area.

Historically, the NCI has played an important role in research on the cancinogenic effects of radiation. During the 1940's and 1950's, the pioneer studies of Egon Lorenz contributed significantly to our understanding of low-level radiation carcinogenesis through systematic investigation of effects in chronically exposed experimental animals. At the same time, one of the first clear indications that occupational exposure to radiation can cause an increased incidence of leukemia was reported by Henshaw and Hawkins, based on their investigations of the death records of early U.S. radiologists.

The studies of Harold Blum and his colleagues on the carcinogenic effects of ultraviolet radiation constitute another classical research contribution dating from the same era. One of Blum's associates, Dr. Alexander Hollaender, was detailed to the Manhattan project at Oak Ridge in the mid-1940's where he became the director of the biology division of the Oak Ridge National Laboratory.

Since the 1950's the National Cancer Institute has continued to remain active in research on radiation carcinogenesis. However, its efforts have not equalled, in scope or magnitude, those of the Department of Energy—formerly, the Atomic Energy Commission and the Energy Research and Development Administration. Nevertheless, the NCI has maintained close liaison with this and other organizations, cooperating and collaborating in those areas of mutual interest where joint efforts have had the most promise of being advantageous and fruitful.

In the remarks that follow, I will be speaking primarily about ionizing radiation, which includes X-rays such as are encountered in medical and industrial exposure. However, I will refer also from time to time to research on nonionizing radiation such as ultraviolet and microwave radiations.

Exposure to low-level ionizing radiation which may cause no noticeable change in the exposed individual himself, may cause changes in the genes of the germ cells which are passed on to, and cause abnormalities in, the offspring of the descendents of the exposed individual. Such changes are called mutagenic effects. On occasion, with low-level radiation, damage to one or a few cells of the body may also cause an increased risk of cancer in the exposed individual himself, exposed years or decades later. This is called a carcinogenic effect. If a pregnant woman is exposed to low-level radiation, disturbances in the development of the embryo or fetus or later cancer in the childhood of the fetus may result. The former effects, effects on growth and development, are known as teratogenic effects. These three types of changes, mutagenic, carcinogenic and teratogenic, are broadly referred to as stochastic effects.

It is generally believed that even at very low levels of exposure, there is no dose without some risk of such effects, and that as the dose of radiation increases, the frequency with which these effects may occur increases as well.

The risks of these stochastic effects have been of greatest concern in setting standards for the protection of populations against radiation injury. Efforts to estimate the exact risks have been carried out continuously by various national and international boards of experts during the last 25 years. These boards have included the U.S. National Academy of Sciences Advisory Committee on the Biological Effects of Ionizing Radiation—the so-called BEIR Committee; the National Council on Radiation Protection and Measurements of the United States; the International Commission on Radiological Protection; and the United National Scientific Committee on the Effects of Atomic Radiation, the so-called UNSCEAR Committee.

The two most recent comprehensive and detailed reports from the above groups of experts are the BEIR report of 1972 and the UNSCEAR report of 1977. In both these reports, the risks of low-level radiation are assessed in detail, based on considerations of the relevant observations in human subjects, analyzed in the light of knowledge of dose-effect relationships and mechanisms of injury derived from cogent research in laboratory animals. The two reports are in reasonably close agreement in their estimates of the risks of genetic injury to the off-spring of irradiated individuals and of the risks of carcinogenic effects in the irradiated individuals themselves. Both reports also agree in their conclusion that numerical risk estimates for teratogenic effects of low-level radiation in human populations cannot be derived without further information than is now available.

In deriving risk estimates for genetic effects, both reports make allowances for the fact that X- or gamma-irradiation has been observed in experimental animals to be several times less mutagenic at low dose rates than at high dose rates, owing presumably to greater repair of damage at low dose rates. That is, for a given dose, the yield of mutagenic effects is smaller at low dose rates than for the same total dose delivered at high dose rates.

Based on the risk estimates, it may be inferred that exposure to natural background radiation, averaging roughly one-tenth of 1 rem per year, would account for less than 1 percent of all naturally occurring diseases attributable wholly or in part to genetic defects. These genetic defects in the aggregate are thought by the National

Academy of Sciences to affect approximately 60,000 of every million persons, or about 1 in every 17 members of the population.

The overall risk estimates for cancer in population exposed to whole-body radiation, as stated in both reports, imply that exposure to natural background radiation could account for about 1 percent of the total national cancer incidence. The relative frequencies of cancers of different types in irradiated populations differ, however, from those in nonirradiated populations, depending on age at the time of irradiation and the conditions of exposure. In general, the cancers occurring at excess after irradiation include cancers of the female breast, thyroid gland, blood-forming organs—which include the leukemia and lymphomas—the lung, the gastrointestinal tract and skeleton, in decreasing order of frequency for the same amount of exposure. It is emphasized in both reports that these estimates are based on data derived from epidemiological studies of irradiated populations, the interpretation of which is fraught with several sources of uncertainty.

One of the most important sources of uncertainty results from the fact that the data on which risk estimates are based come primarily from observations at relatively high doses and dose rates of exposure. It is not known whether the relationship between the level of exposure and the incidence of cancer at high levels applies also at low levels. The estimates of low-level risk also may fail to allow for the capability of the body to repair radiation injury at low doses and dose rates. There is, furthermore, usually some uncertainty about the doses of radiation actually received by the individuals under observation. In addition, data on the frequency of cancer incidence in irradiated populations cannot always be considered complete, because some of the populations under observation are continuing to develop new cases of cancer. Finally, we cannot be certain of the influence of variables other than radiation on the incidence of cancer of the various types.

Despite the uncertainties mentioned, the above risk estimates for genetic effects and for carcinogenic effects of low-level irradiation are generally acknowledged by responsible authorities to be as sound as present knowledge permits. Hence, they have been used by the International Commission on Radiological Protection and the Environmental Protection Agency as a basis for evaluating the adequacy of existing radiation protection standards. Similarly, the National Cancer Institute has used comparable estimates of the carcinogenic risks that may be associated with mammography, derived by an ad hoc scientific working group, as a basis for evaluating the risk/benefit relationship in mass screening of the population for detection of breast cancer. In utilizing such risk estimates, their limitations must always be kept in mind, and any conclusions based on them must be qualified accordingly. Estimates to refine the estimates should be encouraged and supported to the extent that there are promising approaches to do so.

Current activities of the National Cancer Institute in radiation carcinogenesis can be broken down into several general areas. One broad area of research concerns the effects of exposure to radiation on basic biological structures. This approach includes studies of both ionizing and ultraviolet radiations.

Another broad area of research is concerned with those factors which may increase or decrease the potential carcinogenicity of radiation. At several institutions investigators are trying to determine the ways in which various chemicals, some of which are used as therapeutic drugs, may act to increase susceptibility to radiation damage, including that caused by ultraviolet light.

The National Cancer Institute also contributes to, and collaborates on, research done by other Federal organizations. For example, the National Council on Radiation Protection and Measurements works to identify sources of radiation risk, to provide accurate measurements of the degree of exposure and to develop means of protection against such exposure. NCI supported centers for radiological physics have been involved in developing technology and applying methods for insuring high quality radiological physics at facilities associated with NCI cancer control programs. For example, these centers developed and administer a system for calibrating and monitoring mammography equipment used in the NCI's breast cancer detection demonstration projects. The centers now are collaborating with the Bureau of Radiological Health of the FDA to test such monitoring systems with State health departments. The Institute is to be represented on a governmental advisory committee that will review and approve the scientific protocol for the proposed broad-based mortality study of personnel present at nuclear tests.

Another broad area of research involves efforts to reduce radiation risk by enhancing the effectiveness of diagnostic and therapeutic radiation technology, while decreasing exposure to the irradiated target organ and surrounding tissue. Much basic research aimed at improving therapeutic radiation through understanding the mechanisms by which radiation destroys cancerous cells can also be applied to understanding how normal cells are affected by radiation.

The bulk of what we know about those cancers caused by exposure to radiation is derived from epidemiologic studies; that is, investigation of excesses of certain types of cancer among populations known to have been exposed to a particular source of radiation. Within the past year, the capability of NCI to conduct and evaluate intramural studies of radiation induced cancer has increased with the addition of three scientists to the epidemiology program. Among the research they are conducting are studies using resources of the Radiation Effects Research Foundation, formerly the Atomic Bomb Casualty Commission in Hiroshima and Nagasaki. These studies have increased our awareness of those cancers which were caused by ionizing radiation from the 1945 A-bomb explosions. They show that radiation induced leukemias have been outnumbered by solid tumors in terms of absolute risk; that age at the time of irradiation influences the carcinogenic effects of exposure, depending on the organ site; and that the radiation effects are generally larger in Hiroshima than Nagasaki, suggesting that neutrons are more potent carcinogens than gamma rays.

A recent epidemioligic study sponsored in part by FDA and being continued by NCI involves women who were exposed to repeated fluoroscopic examinations of the chest during lung collapse therapy for pulmonary tuberculosis. Such treatment has been shown to be associated with an increased risk of breast cancer. The study reaffirms that frequently repeated, relatively low radiation doses pose some future risk of breast cancer, that the risk may be cumulative and that multiple low-dose radiation exposures may convey the same breast cancer risk as a single exposure to the same total dose. The NCI is supporting other extramural research to determine the radiation risk to populations who received repeated low doses of radiation exposure.

An NCI staff scientist, working in Boston, is conducting a long-term followup of children who received radiation treatment for cancer. In another followup study, NCI scientists are collaborating with the Bureau of Radiological Health to evaluate the risk of thyroid tumors among children who were administered low-dose 131-Iodine during diagnostic tests for thyroid. Staff members have helped prepare committee reports to assess the risks and benefits of mammography screening for breast cancer. They have collaborated with the Department of Energy to review and re-analyze a mortality survey of cancer among plutonium workers and, with the National Academy of Sciences, are re-evaluating the biological effects of ionizing radiation.

A final example of the way in which studies of populations may teach us more about particular cancers is a National Cancer Institute survey using particular geographic areas of the country and their tumor registries to clarify the role of solar ultraviolet radiation in the development of nonmelanomatous skin cancer.

These are but some of the activities now being conducted at NCI, funded by NCI research dollars, or carried on in collaboration with NCI by other Federal agencies. At present, however, many questions remain to be answered. A few of these are: What are the risks—precise, numerical risks—at very low doses? How and why do different effects of radiation vary with age at exposure? What is the relationship between dose and response? How does radiation interact with conditions already present at the time of exposure, or occurring after exposure?

What is the fundamental mechanism of radiation carcinogenesis? And, finally, what populations are particularly susceptible to radiation exposure?

To address these and other questions, the National Cancer Institute intends to continue to carry out and support research on radiation carcinogenesis, the interactions between radiation and other environmental and host factors, and the means by which radiation hazards to the public can be reduced.

Mr. Chairman, this concludes my remarks. My colleagues and I will be happy to answer any questions you may have.

Mr. ROGERS. Thank you, Doctor.

May I ask first, if you would agree with Dr. Edward Radford in his testimony here—although not given in his capacity as chairman of the BEIR Committee—that the current risk estimates are higher than the 1972 BEIR report?

Dr. UPTON. I would, sir; yes.

Mr. ROGERS. Would you agree with Radford that the occupational standard should be reduced to 0.5 rem per year?

Dr. UPTON. Mr. Chairman, I think the setting of standards involves the weighing of risks and benefits. It is a societal decision to make. I do not see, on the basis of increased knowledge of the hazards of low-level radiation any justification to reduce the permissible levels by a factor of 10.

It turns out that in practice the average level of exposure is about one-tenth of the maximum permissible level. It is not practicable to permit workers to expose themselves to the limit, as it were.

But I think that, in approaching the question of acceptable levels, assuming that no level is without risk, the decision involves a weighing of risks and benefits.

That is not a decision that——

Mr. ROGERS. What should it be, then? What does the Cancer Institute think it should be?

Dr. UPTON. The Cancer Institute has not attempted to weigh risks and benefits. The International Commission on Radiological Protection has sought to do this and it has taken the position that the average risk to radiation workers should be commensurate with, or no higher than, the average risks in supportedly safe industries.

And the International Commission on Radiological Protection, in canvassing average levels of risk in industry, has concluded that a risk of about 1 death per 10,000 per year represents a level in safe industries and that if——

Mr. ROGERS. Well, now, I remember that some of these groups have set the standards before and they had them up as high as 10 rem per year.

Dr. UPTON. Yes.

Mr. ROGERS. Now, are you saying, basically, that what the safe level is to be is determined by how safe the industry is actually operating?

I thought I understood you to say that.

Dr. UPTON. Well, I think the issue is that there is no safe level.

Mr. ROGERS. I understand that. But you are saying, if I understood you, that if industry operates at this particular level—and most of them, you say, do—then that ought to be the level that we should accept?

Dr. UPTON. I am saying that the International Commission on Radiological Protection has sought to compare average risks to radiation workers with average risks to workers in what are considered to be safe industries. And on that basis of comparison, assuming that the average radiation worker receives no more than a half a rem per year, radiation work is in the same ballpark as supposedly safe industries, because there is less than——

Mr. ROGERS. Well, my concern about that, then, simply is that it turns over to the industry the setting of standards. I did not think that was the way our system worked, but indeed, you tell me, it does.

Dr. UPTON. No, Mr. Chairman, I would not leave it to industry. I believe that these are matters that do involve Federal regulatory agencies.

Mr. ROGERS. Well, I understand. But, if they are basing the standard on how industry operates, it seems to me that we are not necessarily getting to the question as to what is the actual health effect of the low-level radiation dosage.

Dr. UPTON. Mr. Chairman, as a scientist, I would be prepared to try to make estimates of the health effects. I would not be prepared to attempt to set standards for industry in general or for the radiation industry particularly. That, I think, involves inputs from many points of view. It is not simply a scientific question. It involves other kinds of judgments.

Mr. ROGERS. I understand. But I understood that you felt that the international group was setting the standards that way.

Dr. UPTON. That is a matter of fact. The International Commission has, in its report, made that comparison between average risks in radiation workers as estimated and average risks in other industries. I think society is evolving more humane attitudes toward the workplace, and I would expect these to be reflected in increasingly rigorous occupational safety standards.

Mr. ROGERS. Well, it may be that the industry could do a better job in its safety efforts regarding the exposure that the workers receive in a particular plant.

Dr. UPTON. One of the basic policies in radiological protection is that the risks should be as low as is practicable, that one should not, in fact, accept the higher risk because it is labeled "acceptable."

Mr. ROGERS. But that has not necessarily been the practice. Is the average exposure a valid approach to standards setting?

Dr. UPTON. I confess that I have not been involved myself in radiation physics, assessing the problems of the workplace, so I am not in a position to answer that question.

Mr. ROGERS. All right. I will not pursue that.

Now, you are then not in a position to say that the standard should not be 0.5 rems per year?

Dr. UPTON. That is correct.

Mr. ROGERS. All right.

Now, let me ask you this. What about individual critiques of a project that are written and submitted by reviewers? I did not see any of those submitted with the information asked for, for instance, on Dr. Bross' project.

Dr. UPTON. Yes. May I please refer that question to Dr. Joftes?

Mr. ROGERS. Surely.

Dr. JOFTES. Sir, it is the practice at NIH to destroy the individual critiques when the summary statement, the so-called "pink sheet", is prepared. Many Executive Secretaries have been doing this for many years. Others did maintain records for some time, but the practice since I have been the Chief of the branch, which is responsible for review within the Cancer Institute, has been to destroy those immediately following the writing of a summary statement.

Now, even though that project may be ongoing and funded, our procedure is that we very carefully insert into the summary statement every factor that we think could possibly be germane, and make the——

Mr. ROGERS. Who makes the summary?

Dr. JOFTES. Sir?

Mr. ROGERS. Who actually makes up the summary?

Dr. JOFTES. The Executive Secretary of the review body writes the summary, which is prepared in large part from the actual words of the individual reviewers, but additional materials are added for clarity, for editing, and to insure that the document as a whole represents the opinion of first the site visit team, and then second, the review body itself.

Mr. ROGERS. Well, I would be somewhat concerned about that approach, and I think, perhaps, Dr. Upton, you might want to look into that. We just had an experience, as you may be aware, of where the actual individual critiques did not necessarily agree with the conclusions or the facts as presented in the summary.

Dr. JOFTES. Yes, sir.

In this instance, the staff summary which, with minor modifications, became the summary statement, was used at the meeting of the committee and all of the committee members were able to read it. Two of the committee members had been present at the site visit and surely, had there been significant differences between the opinions expressed by the site visitors and the summary statement, the staff summary in this instance, those two gentlemen would have been aware of it and certainly would have raised issue.

Mr. ROGERS. Unless the summary agreed with their position.

Dr. JOFTES. May I also say, sir, that we pride ourselves in not trying to put words into the mouths of anybody——

Mr. ROGERS. Well, I am sure everybody does that. But if there is some prejudice, or strong feeling as we found in another peer review situation, that may bring about some shades of difference in the summary.

Dr. JOFTES. The vote on this one was unanimous and I would be willing to say under oath that the summary statement truly represents the opinions of the site visitors and the reviewers, and this involves 29 people.

Mr. ROGERS. All right. We have their names, do we not?

Dr. JOFTES. Yes, sir.

Mr. ROGERS. Then you considered this a fair review of Dr. Bross, even though it was a different group and was not mainly composed of epidemiologists?

Dr. JOFTES. Dr. Bross was reviewed using routine procedures which insure at NIH a fair, thorough, objective and scientifically rigorous review. There was nothing unusual about this review. We did it as we do all the others.

Mr. ROGERS. Are peer review groups not made up of actual peers in the type of research that is being done?

Dr. JOFTES. In our opinion, he was reviewed by peers. This new proposal, the renewal proposal which we were reviewing, did not only involve biostatistics and epidemiology, it involved radiation; it involved hormones; and one or two other things. We used experts who covered the spectrum of the proposed work in the research.

Mr. ROGERS. Was the work regarding clinical work or——

Dr. JOFTES. Some parts of it.

Mr. ROGERS. Or was it epidemiological work?

Dr. JOFTES. Epidemiological work is generally reviewed by our committee, which does the clinical studies, but there is a spectrum of opinion on that committee. There are not only radiologists, but, as you know from having the list, other kinds of experts as well.

The number of people who are directly interested in radiological research on my committee numbered seven or eight and at least two of them are interested in basic radiological research, and I am quite certain that they do not care about the clinical aspects per se. Their expertise is there to advise the others on the more basic aspects of research which is proposed.

Mr. ROGERS. Dr. Carter?

Mr. CARTER. Thank you, Mr. Chairman.

Over the past few years we have had a mammography program throughout our country. Are you expanding it, continuing it at the same level, or are you diminishing it at the present time?

Dr. UPTON. Dr. Carter, the program was set up as a 5-year demonstration program and it was thoroughly reviewed last fall at a meeting convened at NIH for that purpose, a consensus panel meeting. The recommendation was that it should be continued until its conclusion. I think all of the women have been involved for at least 2 years now. So it is probably about halfway toward completion at the present time.

Mr. CARTER. I see.

Do you foresee an increased incidence of cancer as a result of these mammography examinations?

Dr. UPTON. That is a key question. We cannot exclude that possibility. We have no conclusive evidence that the doses associated with mammography will increase the risk of cancer in the examined women, but we estimate that they are likely to do so. And so the answer to your question is that we would expect some increased risk in the screened women.

Mr. CARTER. Some increase?

Dr. UPTON. Yes.

Mr. CARTER. About what percentage of an increase among those examined would you estimate?

Dr. UPTON. The estimates were that the magnitude of the risks would vary with age at the time of screening.

Mr. CARTER. Yes, of course, but in general what would you expect?

Dr. UPTON. In general, a less than 1-percent increase in the natural risk——

Mr. CARTER. Less than 1 percent?

Dr. UPTON. Per examination.

Mr. CARTER. One percent?

Dr. UPTON. Yes. So on that basis a woman would not double her natural risk until she had received on the order of 100 examinations.

Mr. CARTER. Some of the women have had 10 to 15 examinations, is that not correct?

Dr. UPTON. In the program there was to be an annual examination for 5 years. So the program would have called for five successive yearly examinations.

Mr. CARTER. How many rads per exposure?

Dr. UPTON. When the program was started, the average dose in the screening centers was about 3.1 roentgens at the surface of the breast.

Mr. CARTER. 3.1?

Dr. UPTON. Yes. So this is somewhat more than a rad to the breast itself, per examination.

Mr. CARTER. That 3.1 roentgens refers to a unit of radiation. "Rad" is the radiation absorption dose from 1 roentgen.

Dr. Upton. One hundred ergs per gram.

Mr. Carter. Sir?

Dr. Upton. One hundred ergs per gram of tissue is the rad.

Mr. Carter. What fraction of a rad per examination did you say was used?

Dr. Upton. The present techniques involve an average dose of about a rad per examination, or less —0.25–0.88 rads.

Mr. Carter. About a rad. All right.

Now, 2½ years ago when this program began, what was the average dose?

Dr. Upton. The dose at that time was a little more than twice that.

Mr. Carter. Two rads?

Dr. Upton. At the surface of the breast, 3.1 roentgens.

Mr. Carter. How many rads?

Dr. Upton. It was estimated at that time that the average dose was between 1 and 2 rads to the breast.

Mr. Carter. Between 1 and 2 rads would be absorbed, in other words.

Dr. Upton. That is correct.

Mr. Carter. All right.

And for the 5 years that you continued at that level, that would be a minimum of 5 rads, is that not correct?

Dr. Upton. That's correct.

Mr. Carter. For each person.

Do you think that the cost-benefit ratio in this mammography program is worthwhile?

Dr. Upton. This is the crux of the matter, whether we are, in fact, providing a greater benefit by detecting early lesions than the harm we might do by inducing new cancers that would not otherwise have occurred. Efforts have been made to calculate the risk-benefit relationship and in the report of the advisory group under the chairmanship of Dr. Beahrs, reference is made to calculations by Dr. Richard Chiacchierini of the Bureau of Radiological Health, using his life table analysis, and assuming 100,000 women and a dose of somewhat less than a rad per examination.* * *

Mr. Carter. That would not be exactly right, though, would it? In fact, at first we started at more than 1 rad and then, just last year, you diminished the dose, did you not?

Dr. Upton. It has come down, yes.

Mr. Carter. All right.

Dr. Upton. His calculations, assuming five annual screenings at 1 rad each, were 116 lives saved if 100,000 women entered the screening system at age 50, and 22 deaths caused.

Mr. Carter. Twenty-two deaths caused?

Dr. Upton. Yes. So a benefit-to-risk ratio of roughly 5 or 6 to 1.

Mr. Carter. Five or six to one?

Dr. Upton. Yes. If we assume the doses come down in the meantime, then the benefit-to-risk ratio of women entering at age 50 should have increased.

Mr. Carter. Has there been a change in who has been included in this program since it began?

Dr. Upton. Yes, indeed.

Mr. Carter. Why?

Dr. UPTON. Well, I am gratified to report that one of the NCI staff members, Dr. John Bailar, called attention to the problem of uncertain ratio of risk versus benefit and to the necessity to look critically at that relationship. As a result of his urging and his leadership, a decision was made to change the guidelines and to limit screening to women over 50 unless there was a particular risk factor in their backgrounds.

Mr. CARTER. What was the benefit-risk factor on those below 50?

Dr. UPTON. Well, again——

Mr. CARTER. What was the ground for discontinuing this?

Dr. UPTON. The decision to discontinue with women over 50 is based on the lack of ——

Mr. CARTER. Under 50.

Dr. UPTON. Discontinue under 50.

Mr. CARTER. Yes, sir.

Dr. UPTON. This was based on the lack of firm evidence for benefit in women under 50. The only controlled human study in which this benefit can be examined is a study carried out under the Health Insurance Plan of New York. In that study, there was benefit to women over 50 in terms of a lowered mortality, but in screened women under 50, there was no demonstrable benefit.

Given the absence of a demonstrable benefit from the only study which is relevant——

Mr. CARTER. Was it an absence of benefit or just a 1 to 1 ratio?

Dr. UPTON. No——

Mr. CARTER. Or was it a diminution?

Dr. UPTON. There was no discernible improvement in survival in women under 50.

Mr. CARTER. Sir?

Dr. UPTON. There was no improvement in survival among women screened under 50.

Mr. CARTER. Well, was there an increase in the number of cancers?

Dr. UPTON. No, not to my knowledge.

Mr. CARTER. Not to your knowledge.

Were these women informed of possible risks while receiving such exposure?

Dr. UPTON. Radiation risk statements in the informed consent form first appeared in May 1976. These were strengthened in the informed consent form issued in February 1977 and are being further strengthened in the new form.

Mr. CARTER. Does the reference to risk state that cancer might be caused from the exposure to radiation?

Dr. UPTON. Yes.

Mr. CARTER. What has happened to the participation of women in the program since this cancer risk information has been presented to them? Has participation diminished?

Dr. UPTON. By late April 1977, screening centers had been advised not to accept women for mammographic examination under the age of 50.

Mr. CARTER. I understand that. But since you now have a form which you did not have when this program started 2½ years ago, which explains to them that mammography may cause cancer——

Dr. UPTON. Yes.

Mr. CARTER. Has this resulted in a decreased number of all women, under 50 and over 50, taking the examination?

Dr. UPTON. Yes, sir.

Mr. CARTER. All right. Thank you very kindly on that.

Now, are you following up on these women? Is there a general study on all of them to find out the effects of the mammographies?

We know that, in many cases, there are latent periods between exposure and the time the disease presents itself. Are you following up on all of these women?

Dr. UPTON. The breast cancer detection consensus panel recommended that we follow all women in which there was a diagnosis of cancer. The question as to whether all of the women in the study should be followed was not answered by the panel. It recommended that there be more evaluation of this question.

Mr. CARTER. Well, what has your decision been?

Dr. UPTON. Dr. Beahrs and his working group are evaluating the advisability of conducting a followup of the whole study population, and we hope to have their report within the next month.

Mr. CARTER. Do you not feel that a followup is absolutely necessary, Doctor? With computer techniques as they are today we should have instantaneous retrieval methods for the experience of these different patients.

Do you not think that we should use such techniques to find out, the benefit-risk ratios, and to trace an occurrence of cancer 10 or 15 years from now which might be a result of mammography?

Dr. UPTON. Dr. Carter, I think if such a study can be conducted——

Mr. CARTER. Can be?

Dr. UPTON. Yes. If it——

Mr. CARTER. Will it be?

Dr. UPTON. If it is feasible to carry out such a study and get the information that you——

Mr. CARTER. If it is feasible.

Dr. UPTON. Yes. I think that is the issue.

Mr. CARTER. And there is doubt in your mind as to whether it would be?

Dr. UPTON. There is no question in my mind that the objectives of such a study are meritorious, and that if we can conduct such a study in a way that will yield definitive information, then I believe it is worth doing.

Mr. CARTER. Have you noticed an increase in cancer of the pancreas of multiple myeloma in those exposed to this radiation?

Dr. UPTON. In mammography, Dr. Carter?

Mr. CARTER. Or in any type of radiation.

Dr. UPTON. There has been an increase in the incidence of carcinoma of the pancreas reported from a study of patients who were treated for a crippling form of rheumatism of the spine—ankylosingspondilitis—by radiation therapy to the spinal column. This study was carried out by Drs. Cort, Brown, and Doll in Great Britain, and they did observe an excess frequency of carcinoma of the pancreas.

The incidence of multiple myeloma has been found to be elevated in radiologists. That has been reported by Dr. Edward Lewis, and I believe there is also some new information from the Atomic Bomb Survivors Study. Perhaps Dr. Land could remark on that.

Mr. CARTER. Yes, sir.

What portion of the NCI budget is being spent for research on health effects of low-level radiation?

Dr. UPTON. We are now devoting some $70 million overall to the study of radiation and radiation effects. The fraction of that which relates to low-level radiation injury is relatively small. I would suppose on the order of $5 to $10 million per annum.

Mr. CARTER. Do you think that you are spending that much, $5 to $10 million?

Dr. UPTON. At most, yes.

Mr. CARTER. Could you check on that and include this in the record for us, sir?

Dr. UPTON. Yes, sir. I should be happy to do that.

[The following information was received for the record:]

National Cancer Institute, Low-level Radiation (Current level)

Grants	$2,479,000
Contracts	2,947,000
In-house	188,000
Total	5,614,000

Mr. CARTER. All right.

Have you identified any priorities in this area of research on the health effects of low-level radiation?

Dr. UPTON. Yes; I think that we do wish to increase the effort on epidemiological evaluations of populations exposed to low doses.

Mr. CARTER. Yes, sir.

What is the incidence of cancer from normal radiation which we receive from our environment?

Dr. UPTON. We estimate that natural background radiation—when I say we, the BEIR Committee in 1972 estimated that background radiation might account for perhaps 1 percent or 1 to 2 percent of naturally occurring cancer.

Mr. CARTER. And what is the most common form of this?

Dr. UPTON. In the general population, the most common forms of cancer today are cancer of the lung, the bowel, the breast——

Mr. CARTER. Wait a minute. Let's back up now.

Caused by normal radiation?

Dr. UPTON. I am sorry. I did not understand, Dr. Carter.

Mr. CARTER. What about our exposure—for instance to the rays of the Sun?

Dr. UPTON. Yes.

Mr. CARTER. That is part of it.

Dr. UPTON. In that case, we are dealing with cancer of the skin, the incidence of which is clearly related to latitude and intensity of solar radiation.

Mr. CARTER. All right.

What do we know about the role of alpha emitters in cell mutation or cancer induction?

Dr. UPTON. There is evidence from the study of human populations exposed to radium, or to a radioactive atmosphere in mines which contains alpha emitters, hardrock mines, that the high ion density ionizing radiations from the alpha emitters are more carcinogenic for a given dose than X-rays or gamma rays, low ion density ionizing radiations.

Mr. CARTER. In an atomic blast, if one goes to the site of the blast fairly quickly, and if radioactive dust is around, which of the radioactive particles would he be most likely to inhale?

Dr. UPTON. I am not expert in fission product radiobiology. I would suppose that immediately after the detonation the high fission yield radioiodines, such as Iodine-131, would be the most serious, but I would have to qualify my answer because I am really not expert in this area.

Mr. CARTER. Would you please repeat that, sir? I did not understand.

Dr. UPTON. I feel that any answer I give must be qualified because I do not consider myself an expert in fission product radiobiology. I would suppose that the radioiodines would be the most serious source of risk in the area of the detonation shortly after the detonation itself.

Mr. CARTER. Do you think it would be a good idea for physicians to keep records of radiation exposure of their patients which could be taken with them from doctor to doctor so they would have an up-to-date exposure record available?

Dr. UPTON. Yes; I do.

Mr. CARTER. All right.

Why not follow all of the women involved instead of just those who get cancer in your mammography series?

Dr. UPTON. I think the issue there, as I say, is the feasibility of following that large a population, 280,000 women.

Mr. CARTER. The feasibility. Doctor, that is the only way we are going to find out what the risks are by following these people. It is feasible, it seems to me, and we must do it for all of our studies. The statistical association will show the risks after a time, I would think.

Have you been trained in statistics?

Dr. UPTON. No, sir.

Mr. CARTER. Do you have anyone with you who has been?

Dr. UPTON. Dr. Land.

Mr. CARTER. All right, sir.

I am going to ask you a question which I ask almost everyone here who appears before this committee. At Smoky blast on August 31, 1957, there were 2,235 soldiers wearing film badges. Of these 2,235 soldiers, 447 have been checked, and of that number 8 have leukemia. Other forms of cancer in addition to the leukemia have also been found among "Smoky" soldiers.

Would you consider this figure statistically significant?

Dr. LAND. Yes; I prepared this in advance, because I thought you might ask that.

Mr. CARTER. Sir?

Dr. LAND. I said, I thought you might ask that, because you asked that others, so I went to the national rates, and——

Mr. CARTER. You say it is statistically significant?

Dr. LAND. For leukemia, yes. That is a statistically significant excess. Even if the number of people contacted included all the leukemias.

If, on the other hand, the leukemias include lymphomas and multiple myelomas, it might not be.

Mr. CARTER. This is just leukemia. Of course, there are lymphomas, too.

Do you think that lymphomas are not caused by X-radiation?

Dr. LAND. I think they are.

Mr. CARTER. You think there are. And we have had quite a number of those caused by that, too. We had one witness who came before this committee just last seek who had lymphoma.

Thanks for your answer. Every statistician, I believe, who has testified has agreed and has testified that this figure, which was arrived at by the Center for Disease Control in Atlanta is statistically significant. This finding means a great deal to those who were exposed to that blast on August 31, 1957.

Thank you very kindly.

Mr. ROGERS. I believe it was Dr. Joftes who was—that is the second bell, a call for a vote. The committee will stand in recess for 10 minutes.

[Brief recess.]

Mr. ROGERS. The subcommittee will come to order.

Did you say you basically agree with Dr. Bross' conclusions?

Dr. UPTON. Mr. Chairman, I would have to have the conclusions specified more specifically. I am not sure which of his conclusions——

Mr. ROGERS. Well, for instance, on low-level radiation.

Dr. UPTON. I think Dr. Bross and I would agree that there is no evidence to justify the threshold hypothesis, that one must, for purposes of radiological protection policy, assume no threshold and that involves, then, the assumption that any increase in radiation exposure is detrimental.

I would go along with him in this. I would also agree with him that there are undoubtedly subpopulations of high susceptibility and that one therefore needs to know more about the factors that influence susceptibility to qualify any risk estimates which are applied to the general population in a way that protects particularly sensitive subgroups.

Mr. ROGERS. Well, then, there are not too many areas of disagreement, I take it. In fact, I really did not sense any basic disagreement from his testimony. Would that be true?

Dr. UPTON. I think Dr. Bross and I may differ in the magnitude of the risk that we would calculate to a population. The difference is quantitative and not qualitative. His model may not be a model that I would select, so that the precise numbers he gets are larger than the numbers that I would derive or, to my knowledge, that the National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation would derive.

But they are now looking at the problem, and I am confident that they are paying close attention to Dr. Bross' data, Dr. Bross' interpretations; and they may conclude that his model is the best model. I would not prejudge the issue.

Mr. ROGERS. You have worked on a paper, I believe, while serving on the NCRP committee?

Dr. UPTON. I served as a member of the NCRP and chaired one of their scientific committees; that is correct.

Mr. ROGERS. And what were the basic findings of the committee?

Dr. UPTON. That committee sought to review the effects of low-level radiation and, in particular, how risk estimates for low-level radiation injury might be influenced by dose rate and the quality of radiation—that is, whether we are dealing with alpha particles as opposed to X-rays, as an example. So we did, in fact, try to review all of the cogent information and indicate how risk estimates could, in fact, be expected to vary with dose, rate, and radiation quality.

Mr. ROGERS. Would that study indicate that the low-level effects had been overestimated or underestimated?

Dr. UPTON. That study would suggest that for X-rays and gamma rays—radiations of low ion density or low linear energy transfer—the overall risks per unit dose at low doses and low dose rates should be expected to be smaller, perhaps by a factor of two to three, than the risks per unit dose for a dose of 100 rads or more absorbed at high dose rates. So, to this extent, that committee analysis would argue that risk estimates as derived by the National Academy of Sciences Committee, the BEIR Committee, might be high by a factor of two or three.

Mr. ROGERS. What about the other types of radiation?

Dr. UPTON. For high-LET radiations—alpha particles, fast neutrons, protrons—we would not see evidence for any reduction with decreasing dose or dose rate. On the contrary, we would think that their risk estimates might be too low.

Mr. ROGERS. By a factor of what?

Dr. UPTON. Perhaps another factor or two or a factor of three.

Mr. ROGERS. Now, as I understand it, Dr. Bross' work really is the analysis of the tristate data?

Dr. UPTON. I believe that is correct, Mr. Chairman.

Mr. ROGERS. I noticed that some of the critiques seem to refer to clinical work, and a lack of biological and/or medical understanding.

Dr. JOFTES. Yes, sir.

Mr. ROGERS. Yes, Doctor?

Dr. JOFTES. The renewal application of Dr. Bross is somewhat of a departure from his original supported work that is, the work supported by NCI, in that he was beginning now to start to make interpretations of his data rather than continuing to use biostatistical approaches and to refine those approaches. He was now beginning to enter into the questions of cause and association with the deleterious effects of radiation, and it is on that basis that the reviewers had some difficulties, because he apparently did not have sufficient people with the kinds of backgrounds that would be necessary to achieve intelligible and useful information along those lines to really mount the study and to achieve the objectives which he and they—the reviewers—both believed to be highly laudable.

Mr. ROGERS. Was it not still a statistical study of what has already been found, rather than going out and getting new information?

Dr. JOFTES. It was a question, in the minds of the reviewers, of going beyond the interpretation than the statistics would permit without more knowledge of the biomedical aspects of the conditions he was interested in.

Mr. ROGERS. Was that not really the purpose of the original study?

Dr. JOFTES. As I understand the original study, sir, it was primarily to refine the utilization of biostatistical techniques to the point where they could be used in the fashion that Dr. Bross was proposing to use them now.

Mr. ROGERS. Which is to draw some conclusions about low-level radiation, is it not?

Dr. JOFTES. Yes, sir, precisely.

Mr. ROGERS. Now, how does this new approach differ?

Dr. JOFTES. If I may use an analogy, it is like asking an electrician to work on your plumbing. One must have additional background. Just to use statistical techniques and run things through a computer does not necessarily give correct answers. As you know, the computer people have a saying, "Garbage in, garbage out."

The computer in and of itself does not give any validity to data. It is what you do with the data before it gets into the computer that counts, and how you interpret it when it gets out.

Mr. ROGERS. Well, if you make a judgment on everything before you assemble the facts and analyze them, whatever you put in, I guess, is not going to have much effect.

Yes, Dr. Carter?

Mr. CARTER. I would not assume from your remarks, really, that your people put "garbage" in the computers?

Dr. JOFTES. No, sir. We try not to.

Mr. ROGERS. Let me ask you this, now. I notice another criticism. For example, there appeared to be a clear lack of appreciation for the distinction between radiation damage to parents before conception and that which might occur in uterus.

Dr. JOFTES. Yes, sir.

Mr. ROGERS. And yet his paper, published by the person criticized along with Dr. Bross, clearly makes the distinction.

Dr. JOFTES. Yes, sir. This now verges into the area of the expertise of the reviewers who made these remarks, sir, and I have no personal opinion of that except to say that the reviewer was, in our view, a perfectly good expert in this area and that he surely was aware——

Mr. ROGERS. Well, now, who was this who made this criticism?

Dr. JOFTES. I am sorry. I cannot recall the specific individual at this date. The review was almost a year ago.

Mr. ROGERS. A Dr. Sing, I believe, kept insisting that Dr. Natarajan did not understand the distinction, although the latter had just completed an article comparing the two situations.

Dr. JOFTES. Well, certainly if you have that information, it must be correct. I am also fairly confident that Dr. Sing's comment would not have been allowed to stand if other reviewers had not agreed with it.

It may be a question of interpretation.

Mr. ROGERS. It is in the summary.

Dr. JOFTES. Yes, sir. Scientists do differ.

Mr. ROGERS. I understand. But what is strange to me is that we are beginning to see that these summaries do not necessarily jibe with what true facts are. Now, to use your garbage in and garbage out, if your reviewers are putting garbage in, then out comes a bad judgment on whether to continue a project, is that right?

Dr. JOFTES. Yes, sir, that is possible.

Mr. ROGERS. And obviously this is a fairly heavy discrepancy, I would think, when he has published a paper showing he knows the difference. And yet it is carried forth in the critique, in the summary.

Dr. JOFTES. Mr. Chairman, the scientific literature is replete with erroneous data.

Mr. ROGERS. What causes me concern, is that you would allow that type of erroneous judgment to be the basis for stopping a project that evidently had been ongoing and fairly well accepted until they began to find things that there is some concern about, namely significant health effects from low-level radiation exposure.

Dr. JOFTES. May I assure you, sir, that none of us on the staff had any axe to grind with regard to this research. We are interested in facilitating the best possible research that the Cancer Institute can find to support.

Mr. ROGERS. Dr. Carter, do you have something?

Mr. CARTER. Yes. I just wanted to reinforce what you have said. NCI has itself made a determination to change its mammography program, which shows that there is some validity in the findings of the investigators and reports that we have seen. I want to commend you on that charge.

Dr. JOFTES. Yes, sir. And it was a staff member of the NCI who was instrumental in causing that change. Dr. Bross has never challenged the review of this application on a substantive basis.

Mr. CARTER. It was a result of the investigations by researchers like Dr. Bross which caused you to make this alteration in your plans.

I want to quote from one of you on the mammography program. "I am confident that in a few years mammography will be regarded as an enormous advance in detection of early breast cancer." Who said that?

Dr. UPTON. I did, Dr. Carter.

Mr. CARTER. Yes, sir. "For those over 50," we might have added.

Dr. UPTON. Correct.

Mr. CARTER. All right, sir.

Do you regard that ascorbic acid as a valuable substance in preventing cancer?

Dr. UPTON. To my knowledge, the information on that is inconclusive. I do not think we have any solid evidence one way or another as yet.

Mr. CARTER. Inconclusive? You mentioned that as one of the ways that we might prevent cancer.

Dr. UPTON. Yes. There is evidence from animal studies that it can inhibit the formation——

Mr. CARTER. If that is true, why didn't the Cancer Institute fund Dr. Linus Pauling's investigation of this very thing?

Dr. UPTON. About one out of every two——

Mr. CARTER. He was studying the use of ascorbic acid in the treatment and prevention of cancer.

Dr. UPTON. Less than one out of every two applications we receive at the Cancer Institute is approved for support on the basis of peer review and, of those that are approved by peer review, less than one out of two can be funded within the dollars that are available.

Mr. CARTER. We realize that, but——

Dr. UPTON. So that means that we can only support about one out of four.

Mr. CARTER. We realize that, but you——

Dr. UPTON. And we have to judge those as best we can, and we think the peer review system is a reasonable way to proceed. We do not contend that it is perfect, and I am distressed that Dr. Bross failed to be supported. The vote was unamimous; the disapproval in the review committee was unanimous. We have not heard, or I have not heard from Dr. Bross, that he challenges the statements in the review until this hearing.

Mr. CARTER. Let's get back to the subject here. From you own knowledge you have said that ascorbic acid might be helpful in prevention, at least, and others feel that it would be helpful in treatment. Yet one of the outstanding scientists in our country, Dr. Linus Pauling, has asked you for funds for his project—and yet he has not been funded.

Since you feel there is merit to this field of research, why hasn't Pauling's project been funded?

Dr. UPTON. Mr. Carter, I have written to Dr. Pauling and urged him to come and meet with me and review the situation so that I can assure myself that he has, in fact, had impartial, objective and equitable peer review, and I will be prepared to do that with any investigator who feels that the peer review system has worked somehow imperfectly or to his disadvantage.

Mr. CARTER. He is speaking about the very same things you are talking about.

Dr. UPTON. Indeed he is.

Mr. CARTER. And yet you have not funded that project, Doctor—not for just a few months, but for years.

Dr. UPTON. Dr. Carter, I have——

Mr. CARTER. Do you consider him to be an outstanding scientist?

Dr. UPTON. Dr. Carter, I consider Dr. Pauling to be outstanding. I have invited him to come and meet with me and discuss the problem.

Mr. CARTER. Well, thank you very kindly.

Mr. ROGERS. I also notice in the critique, Dr. Joftes, that on page 10, here again:

> Statistical considerations posed by this study were correspongingly marred by the evident lack of expertise of the investigators in areas of clinical evaluation. In their initial studies, the investigators have applied sophisticated mathematical methods to a very poorly selected base of clinical data.

Now, the clinical data are those which have already been gathered and they are working from these data. You thought that this was a sufficient base for prior approval of the work?

Dr. JOFTES. Yes, sir. Because the prior work was of a nature to refine that data. But, at the review, there did not appear to be any commitment to the further testing of the data to be assured that that data indeed measured what it purported to measure, which is a very large problem in any epidemiological project, as I am sure you are already aware.

Mr. ROGERS. Yes, but why the emphasis on "clinical"?

Dr. JOFTES. Because this is the thrust of the new application.

Mr. ROGERS. To make a——

Dr. JOFTES. To extend the techniques——

Mr. ROGERS. To do a clinical study?

Dr. JOFTES. No, to extend the techniques into the medical area.

Mr. ROGERS. Well, now, just a minute.

Dr. Bross, that was not my understanding. Could you comment on that?

Dr. BROSS. I am afraid I just do not understand that. That certainly was not anything similar to my intention.

I think that perhaps what is involved here is that I was talking about clinical matters when I said that we should try to avoid radiation on this level, because, of course, clinicians deliver it at this level.

But I do not think that the tristate survey was a clinical study. It was an epidemiological study. I think the reason for the word "clinical" throughout this is that I was reviewed by clinicians.

On the entire parent review panel, I do not know of any person whom I would personally classify as competent in this area, who was on the original parent committee panel, except in an ad hoc capacity as coming in for this study.

Mr. ROGERS. Dr. Joftes, did you want to comment on that?

Dr. JOFTES. It is impossible to constitute parent committees which consist of all of the necessary expertise for the reviews which come before them, and therefore we are obliged to use this ad hoc system. It also is extended into the site visit team where there were three people who were either statisticians or epidemiologists.

The chairman of the site visit team is a biostatistician of considerable note, and he was the person who presented this project to the parent committee for its action.

Mr. ROGERS. I would think that in studies for the Cancer Institute as important as the finding of cancer in a particular population, you would assemble an outstanding peer review group for epidemiological work and not have clinicians reviewing epidemiological work.

Dr. JOFTES. Sir, I cannot accept the idea that these were clinicians who had no expertise in the area. There were many radiologists there who are as concerned as we with reducing the irradiation levels to their patients. Their work, the reports of the site visit team which was, I believe, an outstanding one, and the membership of the committee itself is a fine group which would not have lent itself to taking an action which was deleterious either to the Cancer Institute or to biomedical research.

Mr. ROGERS. Well, of course, this is what we also heard about the peer review of the other agency. But the findings there were rather startling.

Dr. JOFTES. I am sure that you, yourself, have drawn the inference and the difference of peer review as it is practiced at NIH and the peer review that was referred to last week.

Mr. ROGERS. That is what we are trying to go into now, to determine whether or not there does exist a difference.

Dr. JOFTES. Yes, sir.

Mr. ROGERS. What was Dr. Sing's field?

Dr. JOFTES. If you will give me a moment, I will check that.

Mr. ROGERS. In fact, you might let us have for the record the vitae of all of the review panel.

Dr. JOFTES. Yes, sir. That is easily available.

Dr. Sing is a specialist in human population, genetics, and statistics.

[Testimony resumes on p. 1045.]

[The following material was received for the record:]

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Kramer, Simon, M.D., Professor and Chairman. Birthdate: 5-22-19, Chisinau, Romania, U.S. citizen. Degrees: Kings College & King's Col. Hosp. Med., 1943. Graduate MCRS, LRCP, 1943. University of London, MB, BS, 1943. Meyerstein Inst. of Radiotherapy, Middlesex, Resident, 1949. Middlesex Hospital, Senior Registrar, Fellow, 1952. Scientific field: Radiotherapy. Honors: Past President—American Society of Therapeutic Radiologists, (December, 1969); Chairman—Committee for Radiation Therapy Studies—(National Cancer Institute); Chairman—Radiation Therapy Oncology Group (National Cancer Institute); and Member—Society of Sigma Xi. Major research interest: Cancer, Radiation Therapy and Radiation Biology. Role in proposed project Principal Investigator. Research support: Radiation Therapy Clinical & Research Center Grant CA 11602—$1,162,628. Head & Neck Cancer Chemotherapy-Radiotherapy Clinical Trial—CA 10542, $87,540. Patterns of Clinical & Research Radiation Therapy—CA 10797, $69,640. Multidisciplinary Cancer Research Center (Planning Grant)—CA 13116, $84,090. Initiation and Development of Radiotherapy Studies (CRTS)—CA 13212, $76,589. Radiation Therapy Oncology Group—CA 12248—$127,338. Research and professional experience: July 1, 1969—present—Professor and Chairman, Department of Radiation Therapy and Nuclear Medicine. April, 1956 to June 30, 1969—Chief, Div. of Radiation Therapy & Clinical Radioisotope Laboratories, Jefferson Medical College and Hospital. 1960 to present—Professor of Radiology, Jefferson Medical College. 1959 to 1960—Clinical Professor of Radiology, Jefferson Medical College. 1956 to 1958—Associate Professor of Radiology, Jefferson Medical College. Publications: "The Biomedical Problem in Radiation Therapy:" An Overview Kramer, S. Presented at the Conference on Particle Accelerators in Radiation Therapy, Conference Proceedings, pp. 6-10, Issued March 1973. "Combination Chemotherapy-Radiotherapy for Stage III Hodgkin's Disease," Hoogstraten, B.; Holland, J. F.; Kramer, S.; Glidewell, O. J. The Archives of Internal Medicine, Vol. 131, pp. 424-428, Published March 1973. "Radiation Effect and Tolerance of the Central Nervous System," Kramer, S.; Mansfield, C. M., Frontiers of Radiation Therapy and Oncology, Vol. 6, "Radiation Therapy and Chemotherapy Combination," Kramer S. Journal of American Medical Association, Vol 217, No. 7, August 16, 1971, "Radioprotective Properties of Dimethyl Sulfoxide (DMSO) Hyperbaric Oxygen," DeMare, P. A.; Kramer, S. Presented at the Annual Meeting of the

Radiation Research Society, in press, May, 1971. "Oxygen Effect on the Production of Radiation-Induced Myelitis in Rats", Asbell, S. O.; Kramer, S. Radiology, Vol. 98, No. 3, pp. 678-681, March, 1971. "The Influence of Treatment on the Survival of Patients with Hepatic Metastases Diagnosed by Liver Scanning", Mansfield, C. M.; Kramer, S.; Southard, M. E. The American Journal of Roentgenology, Radium Therapy, and Nuclear Medicine. Vol. CIX, No. 4, August, 1970. "Liver Scanning in Patients with Suspected or Proven Cancer", Lin, Shu-Ren; Mansfield, C. M.; Kramer, S.; Southard, M. E. The American Journal of Roentgenology, Radium Therapy and Nuclear Medicine, Vol. CVIII, No. 1, January, 1970. "Prognosis in Patients with Metastatic Liver Disease Diagnosed by Liver Scan", Mansfield, C. M.; Kramer, S.; Southard, M. E.; Mandell, G. Radiology, Vol. 93, No. 1, pp. 77-84, July, 1969. "Radiation Therapy in the Management of Brain Tumors in Children", Kramer, S. The New York Academy of Sciences, Section of Biological and Medical Sciences, Vol. 159, Art. 2, pp. 571, 1969. "Tumor Extent as a Determining Factor in Radiotherapy of Glioblastomas", Kramer, S. Acta Radiologica, Vol. 8, February and April, 1969. "The Value of Radiation Therapy for Pituitary and Parapituitary Tumors", Kramer, S. The Canadian Medical Association Journal, 99, 1120-1127, December, 1968. "The Hazards of Therapeutic Irradiation of the Central Nervous System", Kramer, S., Clinical Neurosurgery, Vol. 15, 1968; 62 other publications.

CHARLES E. MENGEL

Mengel, Charles E, b. Baltimore, Md, Nov. 29, 31; m; c. 5. Medicine, Hematology. A.B, Lafayette Col, 53; M.D, Hopkins, 57. Inter, Osler Ward Med. Serv. Hopkins Hosp, 57-58; asst. res. med, univ. hosp, Duke, 58-59; clin. assoc. exp. pharmacol. & therapeut, leukemia serv, Nat. Cancer Inst, 59-61; chief res. & instr. med, univ. hosp, Duke 61-62, assoc. med, sr. staff & faculty, med. center, & dir. med. emergency room facilities, 62-65, organizer & dir. med. ed, Lincoln Hosp, 62-65; assoc. prof. Med. Ohio State Univ. & dir. div. hemat. & oncol., univ. hosp, 65-70; PROF. Med. & Chmn. Dept, Univ. Mo-Columbia, 70- Markle scholar acad. med, 63-68, Student Am. Med. Asn. award. U.S.P.H.S., 59-61, Sr. Surgeon. Am. Fedn. Clin. Res; Am. Soc. Hemat; Am. Asn. Cancer Res; N.Y. Acad. Sci. Nonimmune hemolytic mechanisms; abnormalities of tryptophan metabolism; adult and childhood leukemia; medical education programs, particularly bridging of preclinical and clinical areas, and student and fellow research training. Address: Dept. of Medicine, University of Missouri-Columbia, Columbia, MO 65202.

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WILLIAM L. NYHAN

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MILDRED E. PHILLIPS

Phillips, Dr. Mildred E, b. New York, N.Y., May 21, 28. Medicine, Pathology. B.A., Hunter Col., 46; M.D., Howard, 50. Intern., King's County Hosp., Brooklyn, N.Y., 50–52; res. path., Mt. Sinai Hosp., New York, 52–54; fel. & res. asst. surg. path., Presby. Hosp., 54–55; instr. Path., State Univ., N.Y. Downstate Med. Center, 55–56; fel., postgrad. med. sch., London & London Hosp., 56–57; Instr., Med. Center, N.Y. Univ., 57–58, Asst.

LYLE L. SENSENBRENNER

Lyle L. Sensenbrenner, M.D. Date and place of birth: October 8, 1932; L'Anse, Michigan. Education: Marquette University, Milwaukee, Wisconsin A.B., 1953. University of Michigan School of Medicine, M.D., 1957. Philadelphia General Hospital, Philadelphia, Pa. Intern., 1957-58. Senior Asst. Surgeon U.S. Public Health Service,-NIH, 1959. Fellow in Medicine, The Johns Hopkins University, School of Med., 1961-63. Research and professional experience: Physician, The Johns Hopkins Hospital, 1964. Physician, Medical Clinic (Growth), The Johns Hopkins, 1964-65. Instructor in Medicine, 1964-66. Physician in Outpatient Department, The Johns Hopkins Hospital, 1965. Assistant Professor of Medicine, Johns Hopkins, 1966-72. Associate Professor of Medicine, Johns Hopkins, 1972, Associate Professor of Oncology, Johns Hopkins University School of Medicine, 1973. Source: Grant Application. Present address: Assistant Physician-in-Chief, Department of Medicine, Johns Hopkins Medical Oncology Unit (B-2 S), Baltimore City Hospital, Baltimore, Md. 21224.

JESSE L. STEINFELD

Steinfeld, Jesse L(eonard), b. West Aliquippa, Pa., Jan. 6, 27; m. 53; c. 3. Cancer, Public Health Administration. B.S. Pittsburgh, 45; M.D. Western Reserve, 49; hon. LL.D., Gannor Col., 72. Instr. med. California, 52–54, Atomic Energy Comm. fel., 52–53; instr. George Washington, 54–58; asst. dir. blood hosp., City of Hope, Duarte, Calif., 58–59; asst. prof. med. sch. med., Univ. South. Calif., 59–63, assoc. prof. 63–67, prof. 67–68, chmn. interdept. cancer res. comt. 60–66, chmn. radioisotope comt. 60–66, cancer coord. 66–68; assoc. dir. prog. Nat. Cancer Inst. 68–69; dep. asst. secy. health & sci. affairs, Dept. Health, Educ. & Welfare, 69–72; Surgeon Gen., U.S. Pub. Health Serv. 69- Clin. investr. Nat. Cancer Inst., 54–58, mem. Krebiozen rev. comt. 63–, clin. studies panel, 64–66, consult. 66–, mem. chemother. adv. comt., 67, cancer spec. prog. adv. comt., 67; consult., Vet. Admin. Hosp., Long Beach, Calif., 59–; City of Hope Med. Ctr., 60–; Kern County Gen. Hosp., Bakersfield, 64–; mem. Calif. State Cancer Adv. Coun., 61–, Dipl. Am Bd. Internal Med., 58. U.S.P.H.S., 51, 52–58, Surg. Soc. Nuclear Med.; Am. Asn. Cancer Res.; Am. Med. Asn.; fel. Am. Col. Physicians; Am. Fedn. Clin. Res.; Am. Soc. Hemat.; Am. Soc. Clin. Oncol. (pres., 71); Asn. Mil. Surg. U.S. (pres. elect., 72); N.Y. Acad. Sci.; Int. Soc. Hemat. Cancer chemotherapy; hematology. Address: Office of the Surgeon General, U.S. Public Health Service, Washington, D.C. 20201.

RAINER STORB

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CHARLES W. TODD

Todd, C(harles) W(yvil), b. Hutchinson, Minn., Feb. 3, 18; m. 53; c. 3. Biochemistry, B.A., Minnesota, 50; Ph. D. (chem.), Rochester, 43. Asst. Rochester, 40–43; res. chemist. exp. sta. E.I. du Pont de Nemours & Co., 43–51, res. supvr., 51–60; Guggenheim fel., 61; Nat. Sci. Found. fel., Pasteur Inst., 62–63; vis. lectr. biochem. div., Illinois, 63–66; sr. res. scientist, dept. biol., City of Hope Nat. Med. Ctr., 67–71. Dir. Dept. Immunol., 71–, Immunology. Address: Dept. of Immunology, City of Hope National Medical Center, Duarte, Calif. 91010.

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HUBERT RODNEY WITHERS

Withers, Hubert Rodney, b. Stanthorpe, Australia, Sept. 21, 32; m. 50. c. 1. Radiobiology, Radiotherapy. M.B.B.S., Univ. Queensland, 54. Univ. Queensland Gaggun fel.

Univ. London, 63-65, Ph. D. (path.), 65. Intern. med. Royal Brisbane Hosp., Australia, 57; registr. radiother., Queensland Radium Inst., 58; path. Royal Brisbane Hosp., 58-62; Univ. Queensland Gaggun fel. radiopath. Gray Laos, 63-65; vis. res. fel. radiobiol. Nat. Cancer Inst. Md., 66-68; assoc. prof. Exp. Radiother. Univ. Tex., M.D. Anderson Hosp. & Tumor Inst., Houston, 68-71. Prof. 71-, Nat. Cancer Inst. Res. Grant, 69-. Mem. comt. cellular radiation biol., Los Alamos Mem. Physics Facility, 70-; comn. hazards californium. Atomic Energy Comn., 70-; radiation study secr. Nat. Cancer Inst., 71-. Dipl. Col. Radiol. Australasia, 61. Col. Radiol. Australasia; Ara. Soc. Therapeut. Radiol.; Brit. Inst. Radiol.; Am. Med. Asn.; Radiation Res. Soc.; Brit. Asn. Radiation Res. Response of normal tissues to radiation. Address: Room RI-228. Section of Experimental Radiotherapy, University of Texas M.D. Anderson Hospital & Tumor Institute, 6723 Bertner Dr., Houston, Tex. 77025.

Mr. ROGERS. Genetics and statistics?

Dr. JOFTES. I am sorry. It is human population genetics. There is a misplaced comma there, I believe, and statistics.

Mr. ROGERS. Because he was the one, evidently, who said that these people did not know the difference between in utero or before, even though the paper was published.

Dr. JOFTES. I assume that the committee was aware that the site visit took a day and a half, and that the staff of the Roswell Park Memorial Institute presented to these people over the day and a half, and that there was a great deal of discussion on specific issues. And these evaluations which you have before you in the summary statement are the results of those discussions.

Mr. CARTER. Mr. Chairman?

Mr. ROGERS. Yes.

Mr. CARTER. Who made the statement that someone did not know the meaning of in utero? Did you say that someone on Dr. Bross' staff did not know the meaning of in utero?

Dr. JOFTES. No, sir. The statement was that they were not differentiating between irradiation of the parents and the irradiation of the fetus in utero.

Mr. CARTER. They were not making the differentiation?

Dr. JOFTES. Yes, sir.

Mr. CARTER. OK.

Dr. JOFTES. We are quite certain they do know the difference, but in the discussions, they were not making these differentiations.

Mr. CARTER. I do not think that there would be anyone in any of these fields who would not know the meaning of the term. Of course, it is possible that there would not be a differentiation made.

Are there any alternative routes to funding a research project which has been denied funding through the normal peer review process?

Dr. JOFTES. There are at least two. One is that Dr. Bross was invited to take cognizance of the summary statement, revise his application and reapply. That is on route. He apparently feels that that is futile, because he will go back to the same committee for review.

Another way would be for him to devide the scope of the study into several studies and to come in through what we refer to as the RO-1 route, that is the regular application route, in which case his applications would go to an entirely different review body from ours. Another route would have been for him to have rebutted directly to us on matters of substance, pertaining to the review.

Had we found any cause for error—and we have done this in the past and, in fact, we are currently engaged in doing so—had he rebutted this in a substantive way, we could have arranged for another review either through the same group or, in this instance, perhaps through the use of a totally ad hoc committee, without reference to either the current site visit team or the parent committee which ordinarily would be responsible for this.

Mr. CARTER. What is the so-called unique resources grant?

Dr. JOFTES. I am sorry. I do not recognize that.

Mr. CARTER. You do not know about that?

Dr. JOFTES. No, sir.

Mr. CARTER. Do you know how grants are awarded under this procedure?

Does anyone in your group know about the unique resources grant?

Dr. UPTON. Dr. Carter, I have not heard that term before. I am sorry.

Does anyone on the staff know that?

Mr. CARTER. Dr. Bross has mentioned the unique resources grants in previous discussions. I might ask him if he would describe them.

Dr. BROSS. I believe it is contracts, sir.

Mr. CARTER. Sir?

Dr. BROSS. I believe it is contract, rather than grant. It is unique resources contract.

Mr. CARTER. Unique resources contract?

Dr. BROSS. As I understand it, it is sometimes given to programs where the resources of that particular group are unique in the country, or that sort of thing. It is not competitive.

Mr. CARTER. Yes, sir. And the NCI handles these unique resources contract grants?

Dr. UPTON. There are contracts awarded to contractors because they have unique capabilities, that is correct. It is my understanding that, in every such instance, it is necessary to peer review, that the award is not made without peer review.

But the justification for the award involves a determination that the recipient does, in fact, have unique capability and can be excused on that basis from standard competitive procedure.

Mr. CARTER. They are not subject to standard competitive procedures. Is that correct?

Dr. UPTON. That is my understanding, Dr. Carter. I may stand to be corrected. I am new at this, as you know.

Mr. CARTER. So, these are called unique resources contracts.

Dr. UPTON. Contracts, yes.

Mr. CARTER. Contracts.

Dr. UPTON. Yes, sir.

Mr. CARTER. Thank you very kindly.

Mr. ROGERS. Incidentally, Dr. Carter had requested you to submit for the record the total amount of the annual budget for research for low-level ionizing radiation health effects. Would you also provide a breakdown of this expenditure for the record, describing the project, its principal investigator, the institution with which he or she is affiliated, and the total annual budget?

Dr. UPTON. Yes, sir.

[The following information was received for the record:]

NATIONAL CANCER INSTITUTE

LOW-LEVEL RADIATION GRANTS

INSTITUTION/GRANT No.	TITLE	PRINCIPAL INVESTIGATOR	AMOUNT
Case Western Reserve University R01 CA15901-04	Mutants and Altered Radioresponse of cells and tumors	Earle C. Gregg	$191,248
Colorado State University R01 CA18023-03	Dose and Time Factors in Cellular Radiosensitivity	Joel S. Bedford	102,852
Columbia University R01 CA12536-07	Effects of Small Doses of Ionizing Radiation	Harold H. Rossi	343,084
George Washington University R01 CA19383-02	Increased Sensitivity of Radiopharmaceuticals	Richard C. Reba	35,790
Harvard University R01 CA10941-10	Proliferation and Differentiation of Stem Cells	Samuel Hellman	114,389
Harvard University R01 CA15523-04	Therapeutice/Toxic Action of Election-Emitting Nuclides	S. James Adelstein	65,148
Massachussetts General Hospital R01 CA19622-02	Low-dose Screening techniques for mammography	Lester Kalisher	48,107
Medical University of South Carolina R01 CA18205-02	Radiosensitization by Specific DNA Repair Control	Robert C. Johnson	28,563
Memorial Hospital for Cancer-Allied Diseases R18 CA18309-01	Digital Computerized Mammographic Enhancement	Robert L. Kirch	70,055
National Council on Radiation Protection and Measurements	Radiation Protection and Measurements	W. Roger Ney	45,000
St. Vincent's Hospital and Medical Center R01 CA17582-03	X-ray Dose Rate Effects on Cell Kinetics	George Schwarz	52,707
Sloan Kettering Institute for Cancer Research R01 CA18153-03	Cancer Studies with New Radioactive Scanning Compounds	John S. Laughlin	163,811

INSTITUTION/GRANT No.	TITLE	PRINCIPAL INVESTIGATOR	AMOUNT
Stanford Research Institute International R01 CA16543-01	Investigation of Charge Transfer Electro-Radiography	Ivor Brodie	$ 74,647
Thomas Jefferson University R01 CA19787-02	Low Dose Breast Electron Radiography (Ionography)	Gary S. Shaber	248,757
Tufts University R01 CA16683-03	Radiation Effects on Established Tumor Immunity	Jan Vaage	50,382
University of California (Berkeley) R01 CA14310-05	*In Vitro* Study of Mammalian Cells Damaged by Tritium	Henry J. Burki	56,587
University of Illinois (Urbana-Champaign) R01 CA13779-05	Split Dose Repair--Dividing vs. Postmitotic Cells	Howard S. Ducoff	36,152
University of Rochester R01 CA 21452-01	Screening for Neoplasms in Irradiated Populations	Louis H. Hempelmann	45,196
University of Texas System Cancer Center R10 CA 10953-10	Radiological Physics Centers	Robert J. Shalek	312,900
University of Texas System Cancer Center R01 CA11138-10	The Radiobiology of Normal Issues	H. Rodney Withers	91,980
University of Texas System Cancer Center R01 CA19976-02	Radiomammography with less than 150 MR per exposure	Alfonso Zermeno	86,594

INSTITUTION/GRANT No.	TITLE	PRINCIPAL INVESTIGATOR	AMOUNT
University of Washington R01 CA15844-03	Residual Postnatal Injury from Prenatal x-irradiation	Gerald M. Christensen	$ 56,807
University of Wisconsin R01 CA13881-06	Radiation *In Vitro* and Mammary Cell Survival and Neoplasia	Kelly H. Clifton	126,535
Wright State University R01 CA16477-03	Effects of Radiation on Human Cells Cultured *In Vitro*	George J. Kantor	31,261

National Cancer Institute

Low-level Radiation Contracts

INSTITUTION/CONTRACT NO.	TITLE	PRINCIPAL INVESTIGATOR	AMOUNT
Allegheny General Hospital CN45148	Cancer Control Radiologic Physics Centers	P. N. Shrivastava	$152,048
Alton Oschner Medical Foundation CP65764	Influence of Irradiation on Carcinogenesis	Albert Segaloff	180,357
American Association of Physicists in Medicine CN45162	Cancer Control Radiol. Physics Center Coordinating Committee	Mary Louise Meurk	104,029
Children's Hospital of Philadelphia CP65803	Study Oncogenesis and Late Effects of Cancer Therapy	Giulio J. D'Angio	125,998
Department of Energy CP70504	*In-vivo* Radiation Activation of Endogenous Sarcoma Virus Genome	Emerson W. Chan	216,238
Department of Energy CP60219	Influence of Repeated Low Dose Irradiation on Mammary Gland Carcinogenesis in Estrogenized Rats	Claire J. Shellabarger	187,400
Department of Energy CP30213	Neutron-Hormone Co-carcinogenicity	Claire J. Shellabarger	Extended without funds
Food and Drug Administration CN70602	Mammography Quality Assurance Program	Ronald G. Jans	150,000
Food and Drug Administration CP70506	Follow-up Studies in Cancer: Childhood Exposure to 131-Iodine Thyroid Uptake Tests	Frank E. Lundin	100,000
Harvard University CP33273	Study of Respiratory Carcinogenesis	John B. Little	126,143
Mayo Foundation CN75379	Working Group for the Review of BCDDP's	Oliver H. Beahrs	220,340

INSTITUTION/CONTRACT NO.	TITLE	PRINCIPAL INVESTIGATOR	AMOUNT
Memorial Hospital for Cancer-Allied Diseases CN45057	Cancer Control Radiologic Physics Centers	John S. Laughlin	$258,854
National Academy of Sciences CP53573	Epidemiological Studies	Seymour Jablon	91,945
National Academy of Sciences CP61003	Epidemiologic Research on Cancer	Leroy R. Allen	148,000
National Bureau of Standards CB60308	Development of U.S. Radiation Therapy of an Effective System to Assure Accurate Dosimetry Traceable to NBS Standards	Robert Loevinger	130,000
Netherlands Central Organization TNO CP33330	Study of Interaction of Hormones	Johannes J. Brocrse	172,738
Temple University CP43271	Study of Induced Cancer of the Skin	P. D. Forbes	234,469
University of Colorado Medical Center CN45160	Cancer Control Radiologic Physics Centers	William R. Hendee	112,094
University of Minnesota CP61033	Courses on Principles of Biohazard and Injury Control	Donald Vesley	95,428
University of Texas System Cancer Center CN45150	Cancer Control Radiologic Physics Centers	Robert S. Shalek	62,095
University of Washington CN45158	Cancer Control Radiologic Physics Centers	Peter Wooton	28,768
University of Wisconsin CN45152	Cancer Control Radiologic Physics Centers	John R. Cameron	50,277

Mr. ROGERS. Now, what happens with this material, the research to date on these 13 million people, if a grant is not given? Is it just wasted?

Dr. UPTON. Well, as I said, Mr. Chairman, I am distressed that Dr. Bross has not seen fit either to rebut the unanimous disapproval by the review committee, allow us an opportunity to examine the validity of an appeal process, or to reapply through some other rubric, as Dr. Joftes has indicated.

I, myself, would like to see the material that Dr. Bross has so capably assembled receive the continued study I think it deserves. I am limited as Director of the Institute. We have regulations calling for a peer review process, which I think generally works effectively, limits our ability simply to award funds on the basis of a personal judgment.

Mr. ROGERS. I understand. But, I had understood that you used a different peer review group. Is that true?

Dr. UPTON. Dr. Joftes?

Dr. JOFTES. I think there is a misapprehension here, Mr. Chairman. Originally, Dr. Bross' research was under the aegis of our epidemiology program, which was headed by Dr. Mordecai Gordon. Dr. Gordon eventually was reassigned from the epidemiology program to be my predecessor as the Chief of the Review Branch.

Dr. Bross' first renewal application, which was renewed and funded, was therefore done under the aegis of the Review Branch by Dr. Gordon in his new capacity, and I think it is a natural assumption on the part of Dr. Bross that somehow we have now changed procedures and that the Program Director for Epidemiology would be in charge of this review. This has never been our procedure.

The procedures which we are using have been in place at least since I have been doing this work, which is since August 1976, and if you would like, I can quickly lay out for you how the decisions are made as to which committee and which group will be responsible for the review of an application.

Mr. ROGERS. Well, I think you might restrict it to that.

Dr. JOFTES. All right, sir.

The application comes in. The NIH Division of Research Grants makes two decisions: One, what institute at NIH shall be responsible for the administration of the application; two, what review body shall be responsible for the review of it.

In the case of program projects, nearly all of the institutes have their own review bodies for the purpose of reviewing program projects, as does the Cancer Institute. The application in this case was simply forwarded to the Cancer Institute to our referral officer, who at that time was myself because I did not have a referral officer, and I made the determination that since it was epidemiological and a program project that it would be reviewed by the Clincial Program Project Review Committee.

I have no program responsibility for this application. There is a program director who is responsbile for that. My job is to insure that the application receives a thorough, objective and scientifically rigorous review, and I believe I have done that.

Mr. ROGERS. Is Dr. Copely program director for epidemiology?

Dr. JOFTES. Yes, she is, sir.

Mr. ROGERS. Is she here?

Dr. UPTON. She is not present.

Mr. ROGERS. She is not?

Dr. UPTON. No, sir.

Mr. ROGERS. What did she have to do with this? Anything?

Dr. JOFTES. This being a review matter, we thought it best that I appear rather than she.

Mr. ROGERS. That was not my question. I said what did she have to do with this?

Dr. JOFTES. Oh, I am sorry. She is responsible for the scientific administration of the application. She is the person that Dr. Bross would turn to for advice about Cancer Institute policy if he needed to—as in a couple of instances he did—he wanted to rebudget or he wanted some advice on how to prepare his application, that sort of information would be forthcoming from her.

Mr. ROGERS. You are telling me, then, that all epidemiology programs are reviewed by the clincial peer review group that reviewed this one?

Dr. JOFTES. If they are program projects and assigned to the Cancer Institute, yes, sir.

Mr. ROGERS. It is all by the same peer review group?

Dr. JOFTES. With different site visiting teams, but the parent committee would be the same, yes, sir.

Mr. ROGERS. And how often does that group change?

Dr. JOFTES. Twenty-five percent of the membership changes every year.

Mr. ROGERS. How much?

Dr. JOFTES. Twenty-five percent.

We are constrainted in the types of people who are nominated and appointed to that committee by the types of research that we receive to review. We do not receive so many epidemiology applications that it is reasonable to have a resident epidemiologist on the committee, although we would like to have one. At the moment, we do not.

Dr. Greenhouse who was the chairman of this site visit team and was a committee member, has resigned because of the press of other duties.

Mr. ROGERS. And you had Dr. Barron who was, what, from the College of Physicians and Surgeons?

Dr. JOFTES. Yes, sir.

Each individual was selected because the executive secretary believed that that individual would provide expertise to the review. In this instance, Dr. Barron is an obstetrician and gynecologist. There was a project in this program project on breast cancer, the hormonal relationship to breast cancer induction. He also has a Ph. D. in statistics.

Mr. ROGERS. How about Dr. Wolff Kirsch?

Dr. JOFTES. Sir?

Mr. ROGERS. Dr. Wolff Kirsch?

Dr. JOFTES. Wolff Kirsch is a consultant member to the committee. We attempt, whenever possible, to have at least two committee members present at the site visit. This gives a more rounded view to the parent committee when there are two people to report on what happened than were there is only one and also on the odd occasion where the chairman may become ill, or stopped by weather, or grounded by plane flight problems, that someone will be there from the parent committee.

Mr. ROGERS. And Mr. Seymour Jablon?

Dr. JOFTES. Yes, sir.

Mr. ROGERS. Is that a Mr. or a Dr.?

Dr. JOFTES. He has a master's degree and he is a very highly regarded statistician, sir, and I believe he is present.

Mr. ROGERS. You were with us before, I believe, were you not?

Mr. JABLON. Yes, sir.

Mr. ROGERS. Had you ever worked for the Atomic Energy Commission or ERDA or DOE?

Mr. JABLON. I have never worked directly for them. I had a contract for some time with the NIH, working on a contract which was funded by NIH.

Mr. ROGERS. Thank you.

Dr. Marvin Kirschner?

Dr. JOFTES. He is an endocrinologist and specialist in internal medicine. Again, this would bear on the breast cancer induction work.

Mr. ROGERS. And Dr. Herman Libshite?

Dr. JOFTES. He is a diagnostic radiologist and he was there because of the radiation aspects of the research.

Mr. ROGERS. I think you told me about Dr. Sing.

Dr. JOFTES. Yes, sir. Human population genetics and statistics.

Mr. ROGERS. And Dr. Robert Spirtar?

Dr. JOFTES. He is a doctor of public health in the illness effects section of the surveillance branch of the National Institute for Occupational Safety and Health, and I believe, also a statistician and epidemiologist.

Mr. ROGERS. And Dr. Philip Cole?

Dr. JOFTES. Dr. Philip Cole is a very well-known cancer epidemiologist.

Mr. ROGERS. Dr. Bross, may I ask if you were adequately informed of how you might appeal this turndown and what actions, if any, you have taken?

Dr. BROSS. My contacts with the National Cancer Institute in this entire incident have been through Dr. Coply. She is my grants manager, she is very helpful, and frankly, if it had been under her jurisdiction, we would not have had this situation. But I did, after the review came back and we were cut off—or we were not renewed—attempt to talk to her about this, and I indicated at that time—and I would presume that she would communicate this to Dr. Joftes, but perhaps that is not true, that I did not want to go through the mill again with the same group and get the same results, because this really takes a lot of time and effort to bring the staff up, and I did not want to spend all my time in grantsmanship.

I asked her if there were alternative routes that I could take to avoid this, because I just—I could not even seriously consider at that point bringing my staff back for this, because they were terribly upset by what had happened.

However, I did not get any particular response to this other than, "Well, you will have to go through the regular arrangements." That would mean going back to the same review group that we had gone to before. So I felt that certainly I communicated my dissatisfaction with the way the results had come out—I do not think I made any secret of that at any time. I am a little surprised that anybody would be surprised that I was unhappy, since I think I went quite public on this.

I did not get, as I said, alternative suggestions that I felt could keep this study alive.

Mr. ROGERS. Is it a normal process to turn down projects if junior researchers, they feel, are not competent, or is the grant and approval given to the principal investigator, as his responsibility.

Dr. JOFTES. In this instance, sir, we're dealing with a program project, which is expected to be a group of fairly coequal investigators working together so that they may facilitate each other's research in a way that the whole will add up to more than the value of the parts alone.

In the instance of this application, the reviewers felt that this certainly was not the case, that Dr. Bross was the be-all and end-all of this application, and although the statement is not clearly made here, this is more a characteristic of a regular grant application, an R01, than the P01 (program project) and may have been a very minor feature of the decision to disapprove this application.

Mr. ROGERS. What is the difference between a departmental grant and a program project grant, and why was this reclassified?

Dr. JOFTES. In replying to this, I am going a little bit beyond my own experience, because I have not been in the Cancer Institute during the period when departmental grants were made, but if I may try to be responsive—and be corrected, if I am incorrect—early on, the idea was to get good research funded and going as fast as possible, and many different approaches were taken, amongst them giving almost block grants to where we thought there was a good group of people—when I say "we," now, I am speaking of the Cancer Institute, not myself, as shown by review.

As time wore on, it became clear that people did not always stay in the department, or the chairman would change, or directions would change, and that this did not turn out to be a very satisfactory way of judging what would happen.

There was then, about 4 years ago, a beginning of a change within the Cancer Institute philosophy that less and less of that would be done, but to spread the change out over a period of time so as not to really create too much interruption within any single department and to allow for a more formal system of application, such as the program project for the individual research application.

Mr. ROGERS. Who made the judgment to change the status of this project? Are there any departmental grants still given?

Dr. JOFTES. I do not know of any of my own knowledge, sir, but there may still be one or two. But we have, over the past 3 years, been advising all of our grantees if they have such a type to switch over, and we have tried to be lenient about the timing of this.

Mr. ROGERS. Would you let us know, for the record, if there are any, and to the extent to which they exist? And would you furnish the committee with a list of grants and contracts in this area?

[Testimony resumes on p. 1074.]

[The following information was received for the record:]

R01 CA15901 04 RAD GREGG, EARLE C Radiation

CASE WESTERN RESERVE UNIVERSITY 04/01/77 - 03/31/78
CLEVELAND OH FUTURE YEARS: 2

MUTANTS AND ALTERED RADIORESPONSE OF CELLS AND TUMORS $000191248

Our objectives are several fold: A. To produce radiation resistant mutants from a stable strain of mammalian cells growing in various environments of radiation and in combination with various carcinogens and chemotherapeutic agents. Radiations of differing LET are also to be used. B. To quantitate the overall mutation rate for radiation resistance as a function of LET and dose rate including the simulation of a fractionated radiation therapy regimen. C. To elicit the basic mechanism of the induction of mutants by radiation and to investigate the possibility of synergism with other mutagenic agents. D. To identify, describe and assess biochemical, biophysical and cytological differences between the mutants and the parent strain.

The attainment of these primary objectives will sharply extend our understanding of radiation resistance and perhaps lead to new radiation modifiers in cancer radiotherapy. Further, quantitative information on the production of radioresistant mutants as a function of dose delivery could lead to new fractionation schedules designed to minimize radioresistant tumor regrowth during and after therapy. Lastly, quantitation of mutation rates due to radiation in conjunction with other agents could have impact in both radiotherapy and regulation of environmental contaminants.

R01 CA18023 03 RAD BEDFORD, JOEL S Radiation

COLORADO STATE UNIVERSITY 06/01/77 - 05/31/78
FORT COLLINS CO FUTURE YEARS: 1

DOSE AND TIME FACTORS IN CELLULAR RADIOSENSITIVITY $000102852

The objectives of the proposed investigations are to obtain a better understanding of the nature of lesions and processes leading to cell reproductive death, and to study the interrelationships of factors which influence radiosensitivity with an emphasis on their implications for radiotherapy.

A quantitative comparison would be made of cell killing and chromosomal aberration production by fluorescent lamp irradiation following different schemes of BUdR incorporation using synchronous cell cultures. We plan to examine the intermediate development of damage to chromatin during interphase by inducing premature chromosome condensation (PCC) following a variety of different treatments. The nature of the G2 delay and a mitotic block produced by continuous irradiation with gamma-rays at low dose-rate will also be examined.

In recent years, much attention has been given to the possible radiotherapeutic advantages of elaborate and expensive treatment modalities such as the use of neutrons, protons, or negative pi mesons, while very few workers have focused their attention toward understanding the successful use of low activity interstitial or intracavitary sources. The advantages of the latter may well involve dose-rate as well as dose distribution. We plan to continue studying the effects of dose-rate and multi-fraction acute dose regimes on the life cycle and survival of mammalian cells in culture.

P01 CA12536 07 SRC ROSSI, HARALD H Radiation

COLUMBIA UNIVERSITY 06/01/77 - 05/31/78
NEW YORK NY FUTURE YEARS: 1

EFFECTS OF SMALL DOSES OF IONIZING RADIATION $000343084

A major effort will be to use protons, deuterons and 3He particles, in the track segment method, to produce defined LET values up to 150 keV/micron. Synchronized Chinese hamster cells, at several phases of the cell cycle, will be used to determine the reaction between cell killing and LET. In parallel experiments, the production of chromosome aberrations will be studied as a function of LET.

Using the hamster embryo system, an attempt will be made to discover the factors which lead to the striking difference in transformation frequency according to whether cells are irradiated in utero or in situ. With the T10 1/2 cells, the transformation frequency will be determined for gamma rays in protracted exposures at low dose rate, and also for alpha particles.

BIBLIOGRAPHIC REFERENCES: Rossi, H.H. "A note on the effects of fractionation of high LET radiations." Radiation Res., Vol. 66, pp. 170-173, 1976. Rossi, H.H. "Interrelation between physical and biological effects of small radiation doses." Reprint from Biological and Environmental Effects of Low-Level Radiation, Vol. 1. IAEA-SM-202/509, pp. 245-251, Vienna, 1976.

GEORGE WASHINGTON UNIVERSITY 07/01/77 - 06/30/78
WASHINGTON DC FUTURE YEARS: 0

INCREASED SENSITIVITY OF RADIOPHARMACEUTICALS $000035790

The objective of this program is to develop an improved 67Ga radiopharmaceutical which will have a lower concentration in normal tissue than the present agent 67Ga citrate. To this end three different chelating agents were used with 67Ga - tartrate, 8-hydroxyquinoline and transferrin. None of the three produced increased tumor to blood ratios and none decreased the liver uptake.

Two chelating agents were used in an attempt to lower the concentration of 67Ga in normal tissue after the injection of 67Ga citrate. Neither EDTA or BAL changed the clearance rate of 67Ga from the blood. However, the clearance rate from the liver was increased by the injection of EDTA. Approximately 33% of the 67Ga was removed from the liver by the injection of EDTA after the injection of 67Ga citrate.

R01 CA10941 10 RAD HELLMAN, SAMUEL Radiation

HARVARD UNIVERSITY 09/01/77 - 08/31/78
BOSTON MA FUTURE YEARS: 2

PROLIFERATION AND DIFFERENTIATION OF STEM CELLS $000114389

These studies are concerned with various assessments of the acute and long term effects of radiation and chemotherapy on hematopoietic stem cells. Acute survival characteristics and changes in differentiation have been studied. Stimulation for proliferation (recruitment) has also been determined. Most recent studies are concerned with whether hematopoietic stem cells have limited proliferative capacities and if so, how these are affected by a variety of cytotoxic agents.

BIBLIOGRAPHIC REFERENCES: Bloomer, W.D. and Hellman, S.: Normal Tissue Responses to Radiation Therapy, N.E.J.M. 293: 80-83, 1975.

R01 CA15523 04 RAD ADELSTEIN, S JAMES Radiation

HARVARD UNIVERSITY 05/01/77 - 04/30/78
BOSTON MA FUTURE YEARS: 2

THERAPEUTIC/TOXIC ACTION OF ELECTRON-EMITTING NUCLIDES $000065148

It has been shown in our laboratory and others that the Auger effect accompanying 125I decay is extremely toxic when 125I is incorporated into cellular DNA in the form of iododeoxyuridine (125IUdR). We now propose to use the established cell culture test system to compare the toxicity of 125I when it is uniformly distributed throughout the cell in the form of iodoantipyrine with that of 125I affixed to DNA. In addition, the toxicity of other Auger electron emitting radionuclides (including 57 Co, 67Ga, 75Se, 99mTc, 111In, 113mIn and 201 Tl) and some alpha emitters will be tested in the same system and compared with that of 125I. The intracellular distribution of various compounds labeled with these nuclides will be measured and its relationship to their biological consequences determined. This information will be used to establish the potential biohazards or therapeutic benefits of some of the compounds. The therapeutic efficacy of such compounds will be further examined and compared with 125IUdR in the mouse ascites tumor model previously established in this laboratory.

We also propose to investigate the mechanisms and various aspects by which Auger effect causes biological damages. First, relative sensitivities of various cell lines to Auger electrons and low LET radiations will be compared and the differences related to their variations in nuclear size, DNA content, chromosome number and the cellular ability to repair single-strand breaks. Secondly, cytogenetic changes will be scored in synchronized cell cultures exposed to Auger and alpha emitters and the results interpreted in relation to their lethal effects. Thirdly, the effects of oxygen and anoxic sensitizers on the biological toxicity of Auger electrons will be determined. Lastly, an electron spin resonance study of 125IUdR will be initiated to elucidate the action of Auger electrons at the molecular level.

R01 CA19622 02 RAD KALISHER, LESTER Diag. Resrch & Prev.

MASSACHUSETTS GENERAL HOSPITAL 07/01/77 - 06/30/78
BOSTON MA FUTURE YEARS: 1

LOW-DOSE SCREENING TECHNIQUES FOR MAMMOGRAPHY $000048107

It is proposed to develop, test physically and evaluate clinically a new fast film/screen system for performing mammography with radiation doses lower than those employed at present, without compromising the quality of the radiographic images. The physical performance in terms of speed, resolution, contrast and noise will be measured for existing low dose systems. Combinations of new or experimental screens and available blue- or green-sensitive films, will be tested. Experimental screens will be developed from new phosphor materials with efficient x-ray absorption and high light output using either sputtering or evaporation techniques to maximize the packing density on the screens. It is planned to test clinical efficacy of these screens in the diagnosis of early mammary carcinoma.

R01 CA18205 02 RAD JOHNSON, ROBERT C | Radiation

MEDICAL UNIVERSITY OF SOUTH CAROLINA | 07/01/77 - 06/30/78
CHARLESTON SC | FUTURE YEARS: 1

RADIOSENSITIZATION BY SPECIFIC DNA REPAIR CONTROL $000028563

Radiobiological damage to DNA of bacterial and mammalian cells can be repaired in vivo by two well-established pathways: excision repair pathway and a recA/exr mediated pathway. The recA/exr mediated, gap filling repair plays an important role in survival of cells after X-irradiation and UV irradiation. RecA/exr mediated repair is also considered an important part of the pathway originating with damaged DNA and ending with mutation. Alteration of recA/exr mediated repair with specific drugs, nutritional changes, and physical methods can markedly potentiate the effects of low dose radiation. The primary objective of this study is: (1) to analyze the degree of potentiation of UV and X-ray induced lethality in a genetically well-defined strain of Escherichia coli, (2) to measure the effects on forward mutation, (3) and to correlate different methods as to degree of potentiation with the type of physical-chemical alterations of the repair DNA intermediate. Effective potentiators of lethality but low mutation inductors originating from low intensity radiation would be determined. Classification as to the mode of repair alteration and correlation with successful potentiation of lethality will provide a criteria for further productive investigations. Control and understanding of low intensity radiation-induced damage potentiation through specific alteration of repair should provide explicit procedure for low intensity radiation therapy of cancer tissue.

R18 CA18309 01 CCG KIRCH, ROBERTA L | Cancer Control

MEMORIAL HOSPITAL FOR CANCER-ALLIED DIS | 06/30/76 - 06/30/78
NEW YORK NY | FUTURE YEARS: 1

DIGITAL COMPUTERIZED MAMMOGRAPHIC ENHANCEMENT $000070055

Digital computer enhancement, whcih arose as a development from the Government space exploration program, has been found to be particularly applicable to the enhancement of mammographic images. It is especially successful with films obtained using the Lo-dose film screen combination, a method in which Memorial Hospital was an early investigator. It is intended to determine if computer enhancement can increase the accuracy and specificity of film mammography thereby resulting in earlier diagnosis of cancer of the breast. Three approaches are envisioned: a) A prospective study of post-mastectomy patients and patients with biopsy proven diagnosis of pre-malignant disease by comparing film mammograms with digital computer enhancement of these mammograms. b) Careful histopathologic correlation of enhancement and mammographic findings on those patients undergoing "blind" or "mirror image" biopsy at the time of contralateral mastectomy. Patients in group a who later come to surgery will also be studied in group b. c) A retrospective study of biopsy proven cases will be performed to correlate various enhancement mammographic and histological findings.

R01 CA18001 12 RAD NEY, W ROGER Radiation

NATIONAL COUNCIL ON RAD PROT & MEASUREMS 02/01/77 - 01/31/78
BETHESDA MD FUTURE YEARS: 2

RADIATION PROTECTION AND MEASUREMENTS $000045000

The National Council on Radiation Protection and Measurement (NCRP) and the International Commission on Radiation Units and Measurements (ICRU) seek to collect, analyze, develop, and disseminate information and recommendations on radiation protection and measurement. After identification of an area in which NCRP or ICRU recommendations would constitute a significant contribution, the Council or the Commission initiates research aimed at (1) assessment of the available information which is pertinent to the problem, (2) identification of areas where more information is needed; (3) synthesis of present knowledge relevant to the problem area into practical recommendations on radiation protection and measurement which also highlight areas in need of further study.

The programs of the Council and Commission are broad and continually changing to meet newly identified needs. However, the work is illustrated by the following list of representative projects on which research is underway: (1) photographic dosimetry in external beam therapy, (2) management of radioactive waste, (3) radiobiological dosimetry, (4) biological aspects of radiation protection criteria, (5) microdosimetry, (6) assessment of population exposure from consumer products, medical applications, nuclear power, and occupational exposure, (7) average energy required to produce an ion pair.

R01 CA17582 03 RAD SCHWARZ, GEORGE Radiation

ST. VINCENT'S HOSP & MED CTR NEW YORK 06/01/77 - 05/31/78
NEW YORK NY FUTURE YEARS: 2

X-RAY DOSE RATE EFFECTS ON CELL KINETICS $000052707

The objective of this study is to obtain a detailed picture of cellular kinetics under conditions of continuous irradiation and to investigate whether and how the effects of continuous irradiation can be predictably reproduced by fractionated treatment in four different in vitro cell lines.

The dose-rate effect due primarily to the accumulation of radiation damage and repair was studied by continuous irradiation at various dose rates at temperatures. which slow down or prevent the movement of cells through the cycle.

Dose-rate effects due to differences in the characteristics of the mitotic cycle will be studied by incubating cells during irradiation at temperatures between 28 degrees C and 37 degrees C, a procedure which essentially does not affect the ability of cells to accumulate and repair radiation damage, but which changes the duration of the mitotic cycle by several times. The age dependence of the dose-rate effect will be studied extensively.

An attempt will be made to determine initial slopes of acute survival curves using continuous irradiation at very low dose rates, and by other techniques.

The potential advantages of combining mild (39 degrees C-42.5 degrees C) hyperthermia with continuous irradiation, as well as the effects of short, 45 degrees C-46 degrees C, heat treatments followed by continuous irradiation at various temperatures will be studied.

R01 CA18153 03 RAD LAUGHLIN, JOHN S Diag. Resrch & Prev.

SLOAN KETTERING INSTITUTE FOR CANCER RES 12/01/77 - 11/30/78
NEW YORK NY FUTURE YEARS: 0

CANCER STUDIES WITH NEW RADIOACTIVE SCANNING COMPOUNDS $000163811

The overall objective of these studies is to investigate the degree of tumor localization by certain biologically significant compounds labeled with relatively short-lived radionuclides. Certain labeled compounds will be evaluated as agents for early detection of cancer, and employed in studies of normal and abnormal metabolism. These cyclotron-produced radionuclides have short half-lives which greatly reduce patient exposure, but require detection apparatus suitable for high-energy radiation. These studies will be evaluated in animals and man with quantitative scanning and imaging systems.

Specific proposed studies: (1) Evaluation of Diphenylhydantoin-11C as a Brain Scanning Agent. (2) Evaluation of Valine-11C as a Pancreatic Scanning Agent. (3) Nitrogen-13 Compounds for Tumor and Organ Localization in Human Cancer patients. (4) Preparation and Evaluation of 13N-Nitroso Compounds and 18F-Haloperidol as Diagnostic Scanning Agents. (5) Studies of 73Se Compounds for Tumor Localization in Animal Models and in Human Cancer Patients.

R01 CA16543 01 RAD BRODIE, IVOR Diag. Resrch & Prev.

STANFORD RESEARCH INST INTERNATIONAL 06/30/76 - 02/28/78
MENLO PARK CA FUTURE YEARS: 0

INVESTIGATION OF CHARGE TRANSFER ELECTRO-RADIOGRAPHY $000074647

Electrophotographic methods, as applied to radiology (electroradiography) offer an opportunity for obtaining x-ray radiographs at substantially lower cost, lower dosages, and with rapid daylight development of the radiograph (within a few seconds), as compared with conventional silver halide x-ray film with intensifying screens. This has specific value for the mass screening of populations for cancer and other diagnostics. The objective of the present research is to explore the applicability of a type of electroradiography, called charge transfer radiography, which offers certain fundamental advantages over the currently used Xerox and Xonics methods. A basic machine will be built, complete with control electronics, to study various kinds of x-ray photoconductors that may be used in this device, to obtain detailed measurements of the radiographic parameters of the method and explore various paper and dielectric sheet image receptor surfaces. Experimental radiographs on phantoms and test objects will be carried out for evaluation and if the results warrant, a clinical program will be initiated.

R01 CA19787 02 RAD SHABER, GARY S CREG-CB

THOMAS JEFFERSON UNIVERSITY 07/01/77 - 06/30/78
PHILADELPHIA PA FUTURE YEARS: 1

LOW DOSE BREAST ELECTRON RADIOGRAPHY (IONOGRAPHY) $000248757

The goals of the research project are to develop and evaluate the possible use of elctron radiography (ionography) for large population breast cancer screening with image resolution and breast cancer detectability equal to currently available techniques but with much lower dose per examination. The following characteristics of an electron radiographic mammography image chamber will be determined: 1. Resolution through measurement of its edge spread function (ESF) and line pair resolution of a gold test pattern. 2. Definition through measurement of receiver operating characteristic curves (ROC) and imaging of a modified Stanton mammography phantom. 3. Cancer detection through comparison with conventional techniques (film and xeroradiography) of electron mammographic radiographs of suspected neoplastic breast lesions. 4. Sensitivity through measurement using film and thermoluminescent dosimeters of the dose necessary to obtain optimally imaged abnormal breasts.

R01 CA16683 03 RAD VAAGE, JAN Radiation

TUFTS UNIVERSITY 06/01/77 - 05/31/78
BOSTON MA FUTURE YEARS: 0

RADIATION EFFECTS ON ESTABLISHED TUMOR IMMUNITY $000050382

The project intends to study, with mouse tumor models, effects of radiation therapy on tumor growth and on concomitant tumor immunity. The objective of the study is to indicate safe and hazardous procedures in radiation treatment of antigenic tumors, and to reveal fundamental aspects or radiation biology and tumor immunity. Areas of investigation are: (1) the immunological basis of tumor enhancing side effects of therapeutic radiation, (2) balances of risk versus benefit when tumor cells exist outside the treated area, (3) dosimetry of therapeutic effects versus dosimetry of impairment of immune factors, (4) repair of radiation damage of immune factors.

BIBLIOGRAPHIC REFERENCES: Vaage, J. and Agarwal, S. Serum transfers in repair of radiation-impaired tumor immunity. Proc. Amer. Assoc. Cancer Res. vol. 18, 1977. Vaage, J. A time factor in the success or failure of immune rejection of transplanted tumor. Cancer Res. April 1977.

R01 CA14310 05 RAD BURKI, HENRY J Radiation

UNIVERSITY OF CALIFORNIA BERKELEY 03/01/77 - 02/28/78
BERKELEY CA FUTURE YEARS: 1

IN VITRO STUDY OF MAMMALIAN CELLS DAMAGED BY TRITIUM $000056587

Mouse leukemic cells (L5178Y), human cells (HeLa), and several types of Chinese hamster cells from different tissue sources (V79 lung, M3-1 bone marrow, CHO ovary), will be labeled with precursors of DNA containing tritium, C14, and I125, or tritiated precursors of protein and RNA. After being synchronized by various methods, these cells will then be cooled to 4 degrees C or frozen to -196 degrees C to accumulate damage due to tritium and other isotope disintegration. After suitable time intervals the cells will be thawed out and the reproductive ability and chromosome damage will be determined. The efficiency of cellular inactivation and induction of genetic damage will be compared for damage accumulated in various subcellular regions.

These experiments are designed to further explore regions within the mammalian cell nucleus where isotopic decay appears to be most critical in the induction of reproductive death and chromosome damage. We are particularly interested in the DNA which replicates late in the cell cycle, including some of the sex chromosomes and DNA near the nucleous membrane, as well as tritium damage in satellite DNA. Two other experimental parameters which appear to be quite important, the time in the cycle of the accumulation of damage, and the quality and the repairability of the damage that is formed, will also be studied.

The results of these studies may provide information of two general types: 1) information on the basic mechanisms which lead to the inactivation of proliferative ability of mammalian cells and the induction of chromosome aberrations, and 2) quantitative estimates of the relative hazards to the population from environmental tritium released to the biosphere as a by-product of nuclear power production.

R01 CA13779 05 RAD DUCOFF, HOWARD S Radiation

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN 06/01/77 - 05/31/78
URBANA IL FUTURE YEARS: 0

SPLIT-DOSE REPAIR--DIVIDING VS. POSTMITOTIC CELLS $000036152

Mechanisms of the sparing effect of radiation dose fractionation (sdf) are investigated, using intact insects and insect cells in vitro. Special attention is paid to modification of kinetics of sdf by temperature, because insects are very amenable to temperature manipulation, and to evaluation of repair of noncytokinetic injury, which cannot be scored accurately in mammalian systems. Three manifestations of noncytokinetic injury are under study: Altered longevity in beetles; reduced sexual competitiveness in male beetles; and delayed pupation in diptera. The relative biological effectiveness (RBE) of densely ionizing particles for induction of these phenomena is also under study. Another approach, measuring unscheduled DNA synthesis (UDS), compares mammalian with insect cells, and examines the possibility of induced repair as well as the effect of hyperthermia.

BIBLIOGRAPHIC REFERENCES: Glenn, N. D. and H. S. Ducoff, Acute lethality after fast-neutron and X-irradiation of Tribolium confusum. Radiat. Res. 65, 120-129, 1976. Ducoff, H. S., Radiation-induced increase in lifespan of insects : Implications for theories of mammalian aging and radiosensitivity. IAEA Symposium: Biological and environmental effects of low-level radiation, Vol. I, 103-109, 1976.

R01 CA21452 01 RAD HEMPELMANN, LOUIS H Diag. Resrch & Prev.

UNIVERSITY OF ROCHESTER 04/01/77 - 03/31/78
ROCHESTER NY FUTURE YEARS: 2

SCREENING FOR NEOPLASMS IN IRRADIATED POPULATIONS $000045196

The purpose of this program is to determine the risks of development of tumors in irradiated populations and to evaluate alternatives in diagnosis and treatment of the tumors. The study populations have been followed for 15 to more than 20 years and are at high risk of developing tumors of the thyroid gland (Populations A and C) and breast (Population B). Thyroid palpation and technetium scan will be performed on Population A and Subgroup I or Population C. Follow-up scans using I131 will be performed on those with abnormal screening scans. Population B will undergo mammographic-thermographic studies.

The prevalence of "cold" nodules will be described and the response to treatment with thyroid suppressive drugs will be monitored.

The efficacy of repetitive thermographic-mammographic examination of women at high risk of development of breast cancer will be determined.

R10 CA10953 10 CCI SHALEK, ROBERT J Radiation

UNIVERSITY OF TEXAS SYSTEM CANCER CENTER 09/01/77 - 08/31/78
HOUSTON TX FUTURE YEARS: 0

RADIOLOGICAL PHYSICS CENTER $000312900

The Radiological Physics Center (RPC) was established upon the recommendation of the Committee on Radiation Therapy Studies (CRTS), now the Committee on Radiation Oncology Studies (CROS), under the sponsorship of the American Association of Physicists in Medicine (AAPM) to insure the correctness and consistency of radiation dosimetry between institutions involved in interinstitutional clinical trials. Review of dosimetry is accomplished by visits to the institutions by a physicist, irradiation of various mail-out dosimeters, and by review of dosimetry on patients entered into clinical trials. When errors are discovered, the RPC cooperates with the institution to rectify the errors. To date there are 16 active clinical study groups and 2 intergroup efforts served by the RPC. The RPC is presently monitoring 41 active protocols and following patients on 9 closed protocols. In addition there are at least 14 protocols in planning stages. Visits have been made to 178 institutions. Dosimetry discrepancies have been found at 62 institutions of which 51 have been resolved. Efforts are made to develop calculative methods and efficient techniques for measurements that are important to clinical trials. Experience gained in developing quality control procedures for one clinical trial is communicated to other clinical trial groups. This information and other knowledge gained are communicated to the radiological community.

BIBLIOGRAPHIC REFERENCES: W. Grant, III, J. Cundiff, W. Hanson, W. Gagnon and R. Shalek: Calibration Instrumentation Used by the AAPM Radiological Physics Center. Medical Physics 3: 353-354, (Sept/Oct 1976). W. Grant, III, J.H. Cundiff and W.F. Hanson and R.J. Shalek: Calibration in Water Versus Calibration in Air for Cobalt-60 Gamma Rays. Medical Physics 4, No. 1, p. 68-69, 1977.

R01 CA11138 10 SSS WITHERS, H RODNEY Radiation

UNIVERSITY OF TEXAS SYSTEM CANCER CENTER 01/01/78 - 12/31/78
HOUSTON TX FUTURE YEARS: 0

THE RADIOBIOLOGY OF NORMAL TISSUES $000091980

Lung response to radiation: The time-course of post-radiation pulmonary edema and collagen deposition will be studied with a view to developing preventative treatment with inhibitors of microtubule assembly (e.g. colchicine).

Hypothermia effect on microtubule assembly and cellular radiosensitivity will be studied in vivo and in vitro to evaluate the importance of microtubules in radiation responses.

Spinal cord response to multifraction radiation will be studied to determine the capacity of this tissue for repair of sublethal radiation injury.

Renal tubule response to multifraction radiation using a slow assay system for tubule cell survival will be studied.

R01 CA19976 02 RAD ZERMENO, ALFONSO CREG-CB

UNIVERSITY OF TEXAS SYSTEM CANCER CENTER 07/01/77 - 06/30/78
HOUSTON TX FUTURE YEARS: 1

RADIOMAMMOGRAPHY WITH LESS THAN 150 MR PER EXPOSURE $000086594

The objective of this project is the development of a radiographic imaging receptor capable of producing radiomammograms of equal quality to presently employed systems yet requiring a maximum of 150 mR per exposure to the patient. The methodology herein described employs a selenium plate in conjunction with a high Z gas, during the exposure phase. The latent electrostatic image is then to be developed by means of a scanning optical system thereby converting image detail to an electrical or video signal. This video signal may then be processed making use of conventional electronic circuitry to introduce edge enhancement, gamma manipulation or contrast etc., to produce the most desirable and diagnostic image. This image will be produced on conventional photographic film by means of a synchronously scanning modulated light source. The scan line density will be optimized for highest signal to noise ratio concomitant with the required resolution. The system will be evaluated in terms of its Modulation Transfer Function (MTF) radiographic latitude and noise content and compared to existing systems after which parallel patient studies will be performed to establish the diagnostic capability.

R01 CA15844 03 RAD CHRISTENSEN, GERALD M Radiation

UNIVERSITY OF WASHINGTON 06/01/77 - 05/31/78
SEATTLE WA FUTURE YEARS: 1

RESIDUAL POSTNATAL INJURY FROM PRENATAL X-IRRADIATION $000056807

This project is designed to study the relative lack of repair of radiation injury from fetal exposure which persists in the adult mouse. Pregnant female mice will be given a priming exposure of X-irradiation at various times during gestation. The radiosensitivity of the following tissues and organs will then be measured at various ages throughout postnatal life: Hematopoietic system, gastrointestinal tract, spleen, thymus, and small intestine. A comparison of radiation sensitivity of these systems between mice irradiated in utero and unexposed controls will provide measurement of irreparable injury from fetal irradiation.

R01 CA13881 06 RAD CLIFTON, KELLY H Unknown

UNIVERSITY OF WISCONSIN MADISON 12/01/77 - 11/30/78
MADISON WI FUTURE YEARS: 0

RADIATION IN VITRO & MAMMARY CELL SURVIVAL & NEOPLASIA $000126535

The continuing goal of this project is to gain quantitative information on the number, nature, and acute radiation response of the cells involved in initiation of the neoplastic process which leads to mammary tumors following exposure of mammary cells to ionizing radiation in vitro, and how this process is related to the type of radiation, the dose, and the hormonal exposure of the cells before and after irradiation. The project is divided into short-term studies devoted to development and application of a radiation dose-mammary cell survival assay, and to long-term carcinogenesis experiments. The former will be based on grafting of monodispersed mammary cell suspensions into the mammary tissue-free fat pads of rats which are primed with injected hormones and/or grafted with mammotropin-secreting pituitary tumors. Long-term studies will involve irradiation of mammary cell suspensions in vitro, which will then be grafted in similar animals and observed for tumor development. By these methods we hope to: a) determine the total number of cells of the type from which the malignancy is derived and which survive exposure, b) minimize the abscopal effects of irradiation, and c) develop a system in which both physical and hormonal factors can be manipulated, before and after exposure, for study of cell survival, repair and neoplasia in a quantitative fashion.

BIBLIOGRAPHIC REFERENCES: K.H. Clifton, B.N. Sridharan and M.N. Gould. Risk of mammary oncogenesis from exposure to neutrons or gamma rays. Experimental methodology and early findings. In: Biological and Environmental Effects of Low-Level Radiation, vol. I, pp. 205-211. I.A.E.A. Symposium, Chicago 3-7 Nov., 1975. Vienna: I.A.E.A. 1976. K.H. Clifton. Hormonal influences in mammary neoplasia in irradiated rats. 10th meeting on Mammary Cancer in Experimental Animals and Man. Kobe, Japan, March 29-31, 1976, abstract.

R01 CA16477 03 RAD KANTOR, GEORGE J Radiation

WRIGHT STATE UNIVERSITY 05/01/77 - 07/31/78
DAYTON OH FUTURE YEARS: 0

EFFECTS OF RADIATION ON HUMAN CELLS CULTURED IN VITRO $000031261

The proposed research is designed to study the effects of low doses of ultraviolet and ionizing radiation on specific culture parameters of human embryos, humans of various ages, and humans with either progeria-like syndrome or Xeroderma pigmentosum will be used. The specific culture parameters to be studied are growth rates, DNA and protein synthesis, in vitro age and transformation. Low doses are defined with respect to plating efficiencies and growth rates. The effect of repeated exposure to low doses over a period of time on irradiated populations will be quantitated with regard to the above mentioned parameters. Similar experiments will be done using cultures maintained in a non-proliferating state. Cell strains with normal and defective DNA excision repair mechanisms will be used to determine the significance of DNA repair on these parameters.

LOW-LEVEL RADIATION CONTRACTS, AND INTERAGENCY AGREEMENTS

Contract No. CP 70506

Investigator: Frank E. Lundin

Institution: Food and Drug Administration
Bureau of Radiological Health
Rockville, Maryland

Start Date: 5-1-77

End Date: 9-30-78

Title: Follow-up studies in Cancer: Childhood Exposure to 131-Iodine Thyroid Uptake Tests

Current Award: $100,000

Abstract: 6500 patients given 131-iodine thyroid test at age 15 or younger will be studied.

Contract No. CP 60219

Investigator: Claire Shellabarger

Institution: Department of Energy
Brookhaven, National Lab
Upton, New York

Start Date: 9-30-77

End Date: 9-29-78

Title: Influence of Repeated Low Dose Irradiation on Mammary Gland Carcinogenesis in Estrogenized Rats

Current Award: $187,400

Abstract: Study the influence of repeated low dose irradiation on mammary gland, as well as the effect of DES.

Contract No.	CN 70602
Investigator:	Ronald G. Jans
Institution:	Food and Drug Administration Bureau of Radiological Health Rockville, Maryland
Start Date:	12-1-77
End Date:	9-30-78
Title:	Mammography Quality Assurance Program
Current Award:	$150,000

Abstract: The overall objective is to implement a mammography quality assurance program. In order to accomplish this objective, the following will be done: 1) develop criteria and standards of safe limits of radiation exposure; 2) develop methods and techniques for controlling and reducing radiation exposure; 3) conduct research to determine effects of radiation exposure; and 4) technical assistance for radiological health control program.

Contract No.	CB 60308
Investigator:	Robert Loevinger
Institution:	National Bureau of Standards Applied Radiology Division
Start Date:	10-1-77
End Date:	9-30-78
Title:	Development for U.S. Radiation Therapy of an Effective System to Assure Accurate Dosimetry Traceable to NBS Standards
Current Award:	$130,000

Abstract: The overall objective of this interagency agreement is to develop a system to assure accurate dosimetry for radiation therapy. In order to meet this objective they will: 1) study the method of organization of a national dosimetry calibration system; 2) make a quantitation comparison of different kinds of calibration instruments; 3) study calibration techniques; and 4) verify the reliability of the absorbed-dose calibration system.

Contract No.	CP 70504
Investigator:	Emerson W. Chan
Institution:	Department of Energy Argonne National Lab Argonne, New York
Start Date:	12-14-77
End Date:	9-30-78
Title:	*In Vivo* Radiation-Activation of Endogenous Sarcoma Virus Genome
Current Award:	$216,238

Abstract:	Co-carcinogenesis study of radiation and sarcoma virus.

Contract No.	CP 30213
Investigator:	Claire Shellabarger
Institution:	Department of Energy Brookhaven National Lab Upton, New York
Start Date:	9-30-77
End Date:	3-30-78
Title:	Neutron-Hormone Co-carcinogenicity
Current Award:	extended without funds

Abstract:	Study the interaction of female sex hormones, simple or in combination with neutron radiation

March 11, 1978.
Query No. S036.
Contract: CN45057.
Start date: June 27, 1977.
End date: June 26, 1978.
Current award: 258,854.
Investigator: Laughlin, John S.
Institution: Memorial Hospital for Cancer-Allied Dis, New York, N.Y.
Title: Cancer Control Radiologic Physics Centers.
Abstract: The overall objective of this contract is to significantly improve the quality of radiation treatment and diagnosis in the cancer control projects throughout a determined network of hospitals within an assigned region of the country. Further, the contractor will establish a mechanism for performing intercomparisons with other radiologic physics centers to assure that the standards for all the participating network institutions throughout the Nation are similar and of the same high quality.

March 11, 1978.
Query No. S036.
Contract: CN45148.
Start date: June 28, 1977.
End date: June 27, 1978.
Current award: 152,048.
Investigator: Shrivastava, P. N.
Institution: Allegheny General Hospital, Pittsburgh, Pa.
Title: Cancer Control Radiologic Physics Centers.
Abstract: The overall objective of this contract is to significantly improve the quality of radiation treatment and diagnosis in the cancer control projects throughout a determined network of hospitals within an assigned region of the country. Further, the contractor will establish a mechanism for performing intercomparisons with other radiologic physics centers to assure that the standards for all the participating network institutions throughout the Nation are similar and of the same high quality.

March 11, 1978.
Query No. S036.
Contract: CN45150.
Start date: October 31, 1977.
End date: October 30, 1978.
Current award: 62,095.
Investigator: Shalek, Robert S.
Institution: University of Texas System Cancer Center, Houston, Tex.
Title: Cancer Control Radiologic Physics Centers.
Abstract: The overall objective of this contract is to significantly improve the quality of radiation treatment and diagnosis in the cancer control projects throughout a determined network of hospitals within an assigned region of the country. Further, the contractor will establish a mechanism for performing intercomparisons with other radiologic physics centers to assure that the standards for all the participating network institutions throughout the Nation are similar and of the same high quality.

March 11, 1978.
Query No. S036.
Contract: CN45152.
Start date: September 28, 1977.
End date: June 27, 1978.
Current award: 50,277.
Investigator: Cameron, John R.
Institution: University of Wisconsin Madison, Madison, Wis.
Title: Cancer Control Radiologic Physics Centers.
Abstract: The overall objective of this contract is to significantly improve the quality of radiation treatment and diagnosis in the cancer control projects throughout a determined network of hospitals within an assigned region of the country. Further, the contractor will establish a mechanism for performing inter-

comparisons with other radiologic physics centers to assure that the standards for all the participating network institutions throughout the Nation are similar and of the same high quality.

March 11, 1978.
Query No. S036.
Contract: CN45158.
Start date: June 28, 1977.
End date: June 27, 1978.
Current award: 28,768.
Investigator: Wooton, Peter.
Institution: University of Washington, Seattle, Wash.
Title: Cancer Control Radiologic Physics Centers.
Abstract: The overall objective of this contract is to significantly improve the quality of radiation treatment and diagnosis in the cancer control projects throughout a determined network of hospitals within an assigned region of the country. Further, the contractor will establish a mechanism for performing intercomparisons with other radiologic physics centers to assure that the standards for all the participating network institutions throughout the Nation are similar and of the same high quality.

March 11, 1978.
Query No. S036.
Contract: CN45160.
Start date: September 2, 1977.
End date: June 27, 1978.
Current award: 107,690.
Investigator: Hendee, William R.
Institution: University of Colorado Medical Center, Denver, Colo.
Title: Cancer Control Radiologic Physics Centers.
Abstract: The overall objective of this contract is to significantly improve the quality of radiation treatment and diagnosis in the cancer control projects throughout a determined network of hospitals within an assigned region of the country. Further, the contractor will establish a mechanism for performing intercomparisons with other radiologic physics centers to assure that the standards for all the participating network institutions throughout the Nation are similar and of the same high quality.

March 11, 1978.
Query No. S036.
Contract: CN45162.
Start date: June 28, 1977.
End date: June 27, 1978.
Current award: 104,029.
Investigator: Meurk, Mary Louise.
Institution: American Association of Physicists in Medicine, New York, N.Y.
Title: Cancer Control Radiol. Physics Center Coord. Committee.
Abstract: Cancer Control Radiol. Physics Center Coord. Committee.

March 11, 1978.
Query No. S036.
Contract: CN75379.
Start date: March 11, 1977.
End date: March 10, 1978.
Current award: 220,340
Investigator: Beahrs, Oliver H.
Institution: Mayo Foundation, Rochester, Minn.
Title: Working Group for the Review of BCDDP'S.
Abstract: The objective of this procurement is to establish a working group under this contract to review the overall effectiveness of the breast cancer detection demonstration project program and progress of accomplishment at this time.

March 11, 1978.
Query No. S036.
Contract: CP33273.
Start date: June 1, 1977.
End date: May 31, 1978.
Current award: 126,143.
Investigator: Little, John B.
Institution: Harvard University, Cambridge, Mass.
Title: Study of Respiratory Carcinogenesis.
Abstract: The contractor shall: determine the role of hematite carrier particles in radiation carcinogenesis; identify doses of BP and 210PO which, given individually, will result in a small but measurable tumor incidence; administer both BP and 210PO simultaneously and sequentially to determine synergistic action; and administer DEN systemically following treatment with either BP or 210PO to determine possible synergism of local and systemic carcinogens.

March 11, 1978.
Query No. S036.
Contract: CP33330.
Start date: June 30, 1976.
End date: December 24, 1977.
Current award: 158,730.
Investigator: Brocrse, Johannes J.
Institution: Netherlands Central Organization TNO Rijswijk (Z.H) the Netherlands.
Title: Study of Interaction of Hormones.
Abstract: Investigate the cocarcinogenicity or interaction of female sex hormones singly or in combination with neutron radiation in the induction of breast cancer in laboratory animals. Develop techniques to be used as a basis for the analysis of risk factors involved in radiation induced mammary cancer.

March 11, 1978.
Query No. S036.
Contract: CP43271.
Start date: March 15, 1977.
End date: May 14, 1978.
Current award: 234,469.
Investigator: Forbes, P. D.
Institution: Temple University, Philadelphia, Pa.
Title: Study of Induced Cancer of the Skin.
Abstract: Study of induced cancer of the skin.

March 11, 1978.
Query No. S036.
Contract: CP53573.
Start date: June 28, 1977.
End date: June 30, 1978.
Current award: 91,945.
Investigator: Jablon, Seymour.
Institution: National Academy of Sciences, Washington, D.C.
Title: Epidemiological Studies.
Abstract: The objective of this project is to develop and conduct a cancer epidemiology program designed to make efficient use of the military-veteran population, utilizing medical, demographic and environmental observations made at entry and during military service, and the subsequent medical history of veterans ascertained through facilities of the Veterans Administration supplemented by mortality data. The field studies and statistics program is concerned with studies to identify and clarify each etiologic factor in cancer. Work will include a study of Hodgkin's disease, childhood cancer as it relates to prenatal X-ray, and follow-up of World War II veterans with certain conditions possibly related to cancer (splenectomy, allergy, orchidopexy, nephrectomy, and alcoholism).

March 11, 1978.
Query No. S036.

Contract: CP61003.
Start date: July 1, 1976.
End date: June 30, 1978.
Current award: 148,000.
Investigator: Allen, Leroy R.
Institution: National Academy of Sciences, Washington, D.C.
Title: Epidemiologic Research on Cancer.
Abstract: The Epidemiology Branch of the National Cancer Institute is concerned with the origins of cancer, whether by viruses, chemicals, physical agents, or inheritance. At present, the branch is involved in no research that involves radiation carcinogenesis. By far the best single source of such information is the Atomic Bomb Casualty Commission (ABCC), a collaborative U.S.-Japanese research organization in Hiroshima and Nagasaki. ABCC has made a substantial contribution to the understanding of radiogenic cancer in man. There has been a recent surge in the frequency of cancer other than leukemia among persons under ten years of age at the time of the bomb who received 100 rad or more. This finding suggests that a larger excess in cancer occurrence may become apparent within a few years. This contract does have as a subcontractor the "Radiation Effects Research Foundation" (ABCC) and a subcontract with the Nagasaki Tissue Registry Commission.

March 11, 1978.
Query No. S036.
Contract: CP61033.
Start date: January 1, 1978.
End date: December 31, 1978.
Current award: 95,428.
Investigator: Vesley, Donald.
Institution: University of Minnesota, St. Paul, Minn.
Title: Courses on Principles of Biohazard and Injury Control.
Abstract: Conduct two workshops and short courses relative to laboratory biohazard and injury in Minneapolis at the university's education division facilities. Conduct a three day course annually at the National Institutes of Health in Bethesda, Md. Develop a comprehensive catalog of pipetting aids and safety equipment and submit a manuscript to the project officer. Related activities will be undertaken as described more fully in contractor's proposal dated August 15, 1975, entitled "Development of Training Courses on Biohazard and Injury Control in the Biomedical Laboratory".

March 11, 1978.
Query No. S036.
Contract: CP65764.
Start date: September 30, 1977.
End date: September 29, 1978.
Current award: 180,357.
Investigator: Segaloff, Albert.
Institution: Alton Ochsner Medical Foundation, New Orleans, La.
Title: Influence of Irradiation on Carcinogenesis.
Abstract: It is the intention of the RPF to support laboratory research using known models of synergism in mammary gland tumorigenesis. A number of variables must be assessed in attempting to relate ultimately the developed results to mammographic technology and other forms or radiation exposure.

March 11, 1978.
Query No. S036.
Contract: CP65803.
Start date: September 30, 1977.
End date: September 29, 1978.
Current award: 125,998.
Investigator: D'Angio, Giulio J.
Institution: Children's Hospital of Philadelphia, Philadelphia, Pa.
Title: Study on Cogenesis and Late Effects of Cancer Therapy.
Abstract: Conduct epidemology studies and establish a registry of patients with cancer who have been successfully treated by anticancer therapy and assess the

delay consequences of this therapy including the development of iatrogenic malignancies as well as functional lesions in major organ sites. Identify the acute and chronic cytogenic changes in normal human cells during and after anticancer therapy.

Dr. **Joftes**. Surely.

[The following information was received for the record:]

NATIONAL CANCER INSTITUTE PROGRAM PROJECTS

[Dollars in thousands]

	Actual 1977		Estimate 1978	
	Number	Amount	Number	Amount
Carcinogenesis	7	$6,134	8	$4,464
Epidemiology	8	4,335	6	3,765
Immunology	19	10,914	21	12,112
Tumor biology	13	5,693	11	6,004
Viral oncology	20	11,432	20	12,469
Clinical oncology	31	21,726	37	23,245
Drug development	4	3,244	3	2,707
Radiation	25	17,733	23	21,657
Total	127	81,211	129	86,423

Mr. **Rogers**. The program project grant, then—the grant is not given to a principal investigator? It is given to a group?

Dr. **Joftes**. It is given to a group, although we still, because of legal necessity and other reasons, someone has to be in charge. There is still a named principal investigator, but it is understood that the funding is given to the institution on behalf of the group of investigators, not the single one. That is correct, sir.

Mr. **Rogers**. I notice throughout the summary that it says good things about Dr. Bross: "He is bright, articulate, and experienced in the strategies of research." It says, unfortunately, at the site visit the junior staff who were present as senior investigators on the project gave a rather poor accounting of themselves.

Now, it said:

> This was made especially apparent by the inability to discuss implications of outcomes and assumptions of the mathematical models to be used without referring to Dr. Bross for answers on the issue. Dr. Bross was, and clearly continues to be, the guiding force and competent leader in initiating ideas and supervision the implementation of the research of those ideas.

And then I notice it says, "The methodological competency of the principal investigator is substantial, and the research objectives cited are certainly important." But then the present proposal is not recommended for approval.

Dr. **Joftes**. Yes, sir. The reviewers as a group felt that this proposal would not achieve its objectives.

Mr. **Rogers**. And what will happen to this information?

Dr. **Joftes**. The information, some of it has been published, and I hope other——

Mr. **Rogers**. No; I mean the study, the statistics that——

Dr. **Joftes**. Well, there are many groups working on the basic data, I believe.

Mr. **Rogers**. Well, are you funding any of them?

Dr. **Joftes**. At the moment, not to my knowledge.

Mr. ROGERS. Well, that is what I am asking. What is going to happen with all of this information—the largest mass I know of that could give us some answers—data on 13 million people.

Dr. JOFTES. We will be happy——

Mr. ROGERS. It appears somebody went down for a site visit of a day or a day and a half, has made a judgment that the project should be turned down because of some junior investigators, in spite of the competency of the chief investigator, which is replete through the summary. Apparently no effort was made to suggest to him that he should perhaps replace some of his research staff. Do you always have to go through the whole formal process? Is that normal?

Dr. JOFTES. Yes, sir.

Mr. ROGERS. Well, that is a poor way of operating. I thought you had some discussions with the investigator as to real concerns.

Dr. JOFTES. There was a great deal of discussion at the committee meeting, sir. The committee members exhibited all the concerns which you had just stated, but despite those concerns, they felt that this project per se was not approvable.

We will be very happy to——

Mr. ROGERS. Why not, if the chief investigator was approved?

Dr. JOFTES. Because they felt that the chief investigator alone could not achieve the objective.

Mr. ROGERS. Was there any reason why he could not hire anybody else?

Dr. JOFTES. Sir, you have given the Cancer Institute, in the name of the American people, an awesome responsibility. We are to fund the best research we can. We are trying the best way we know how, through the peer review, to do that.

In this instance, a group of duly constituted experts have said to us that this project was not approvable.

Mr. ROGERS. I understand, but the problem with it is contrary to what they say about the chief investigator. And they say his methodology is good, and it says even that the project is good.

Dr. JOFTES. Yes, sir, but there is a great deal in that review which is negative.

Mr. ROGERS. And some of it in error.

Dr. JOFTES. Perhaps.

Mr. ROGERS. Perhaps? I just pointed it out to you, Doctor.

Dr. JOFTES. No, sir. What you pointed out to me is——

Mr. ROGERS. I pointed out——

Dr. JOFTES [continuing]. Is that there is a difference of opinion between scientists.

Mr. ROGERS. It is a complete error, because Dr. Matarjan has published and it states the difference between *in-utero* and before, in his article.

Dr. JOFTES. Well, sir, that is certainly correct, but that is only one point out of many, many——

Mr. ROGERS. Well, it is a very major point, I would think. I will not pursue that anymore. I expect to go into this in further detail. We will not pursue it at this time because of the vote, but we will want you to come back and go into this in some detail.

There will be other questions we could ask for the record, if you could submit those for the record.

We will ask you to come back at a later date, and Dr. Upton, I wish that you would look into this whole situation. I know that you have just come aboard. I think you need to look at it carefully.

Dr. UPTON. Thank you, Mr. Chairman.

Mr. ROGERS. We will not take another witness until 2 o'clock this afternoon, so the committee will recess until 2 p.m.

[Whereupon, at 1:25 p.m., the subcommittee recessed, to reconvene at 2 p.m. the same day.]

AFTER RECESS

[The subcommittee reconvened at 2:20 p.m., Hon. Paul G. Rogers, presiding.]

Mr. ROGERS. The continuing hearings on the health effects of low-level onizing radiation will be in order.

The next witness will be Dr. Frank W. Putnam, who is professor of molecular biology and biochemistry at Indiana University. Doctor, we welcome you and your colleagues to the committee. Your statement will be made a part of the record, and you may proceed as you wish.

Mr. PUTNAM. Thank you.

STATEMENT OF FRANK W. PUTNAM, PH. D., CHAIRMAN, ASSEMBLY OF LIFE SCIENCES, NATIONAL RESEARCH COUNCIL, NATIONAL ACADEMY OF SCIENCES, ACCOMPANIED BY COUNCILMAN MORGAN, M.D., EXECUTIVE DIRECTOR; DANIEL WEISS, M.D., EXECUTIVE SECRETARY, DIVISION OF MEDICAL SCIENCES; AND SEYMOUR JABLON, DIRECTOR, MEDICAL FOLLOWUP AGENCY

Mr. PUTNAM. Mr. Chairman. We are happy to have this opportunity to discuss with this subcommittee the plans of the National Research Council to assist, if called upon, in the study of the medical aftermath for persons present at atomic bomb tests.

I am Frank W. Putnam, Chairman of the Assembly of Life Sciences of the National Research Council of the National Academy of Sciences and professor of molecular biology and biochemistry at Indiana University, Bloomington, Ind.

Accompanying me are Dr. Councilman Morgan, executive director of the Assembly of Life Sciences; Dr. Daniel Weiss, who is the Executive Secretary of the Division of Medical Sciences within the Assembly of Life Sciences; Mr. Seymour Jablon, Staff Director of the Medical Follow-up Agency of the same Division.

Mr. ROGERS. We welcome all of you gentlemen.

First, it may be useful to recount, briefly, the nature of the Academy and the manner in which we respond to requests for assistance from the Government. The Academy was created by the Congress in 1863 as a private body empowered to make up its own rules and regulations and was directed in its charter to "examine, investigate and report * * * whenever called upon by any department of the government."

As a mechanism whereby to manage such an enterprise and to call upon the full national resource of scientific and technical talent, the Academy organized the National Research Council in 1916 at the request of President Wilson. I may mention that, although we frequently refer to it as the NRC, because of the conflict of acronyms, I am going to try to say National Research Council throughout my presentation.

Mr. **Rogers**. And not National Radiation Committee?

Mr. **Putnam**. Right, or Nuclear Regulatory Commission.

Although significantly reorganized since then, the National Research Council continues as the principal operating mechanism whereby the Academy serves the Government and the American people. The Council today comprises some 800 separate commitees, panels, boards, and so forth, on which almost 9,000 scientists, engineers, and physicians contribute their services without any compensation other than the reward of public service.

When the Government requests the Academy to undertake the study of a specific problem, the matter is first brought to the Governing Board of the National Research Council, which considers the nature of the question itself and whether it is an appropriate question for examination by the Council. If the decision is to accept the task, it is assigned to one of the major elements of the Council, whose responsibility it becomes to design and conduct the study in question.

A committee of appropriate competence and composition is convened for this purpose. Construction of competent, effective, objective committees is an art that the Academy seeks constantly to cultivate and improve.

Within each committee, we seek the wisdom of experience, familiarity with the subject at hand, expertise in the relevant areas, an innovative spirit, a balance of contending interests when these are evident and definable, as well as assurance of objectivity and willingness of each member to devote the time and effort commensurate with the task.

Particularly important is our procedure for recognizing and, if at all possible, eliminating or minimizing any potential sources of bias within the committee. We believe that our process for identifying and appointing members to committees of the National Research Council is conducted in as rigorous and objective a manner as is reasonably possible.

Furthermore, after the study has been completed and after a report has been prepared it is first subjected to a thorough review by the Report Review Committee of the National Academy of Sciences, chaired by the vice president of the Academy. Only after the report has been studied and approved by this independent panel of distinguished scientists and engineers is it transmitted to the governmental unit which requested the study.

Now, with regard to the subject of the atomic tests, the National Research Council was originally invited to send representatives to a joint meeting of the Department of Defense, the Department of Energy, the Center for Disease Control, and the Veterans' Administration to consider the medical problems related to the atomic bomb tests. The group reviewed the early evidence of the appearance of malignancies, especially leukemia, among Americans troops involved in the atomic bomb test "Smoky" which had been investigated by Dr. Glen Caldwell of the CDC.

At the meeting on December 1, 1977, Dr. Caldwell's findings were reviewed and the group recommended that an extensive survey of the military personnel who were present at the test shot be undertaken to determine whether there was significant increase in malignancies among them and to identify those who had suffered such diseases.

During the discussions it was further suggested that other atomic bomb tests which were conducted at the same general time also be included in the study.

In addition, it was recommended that a statistically significant group of a matched control military population also be surveyed among those not engaged in the atomic bomb testing program. In this way, a direct comparison could be made among military participants and nonparticipants which could be made to validate any findings.

The National Research Council's medical followup agency—MFUA—under the direction of the Committee on Epidemiology and Veterans' Follow-up Studies, has conducted many long-term studies of the veterans population in the past. It is presently engaged in a number of studies, for example, of the incidence of cardiovascular disease among amputees, the influence of prisoner-of-war experience on subsequent mortality, and the relationship between sarcoidosis and subsequent cancer.

The value of this program is its capacity for aiding in the resolution of epidemiological questions and its access to and experience in dealing with documents regarding the medical experience of personnel during military service, their subsequent medical care experience, and the array of benefits accorded to veterans by the Federal Government.

Research protocols developed by both independent investigators and by the staff of the Medical Follow-up Agency of the Division of Medical Sciences are reviewed for merit and feasibility by the committee. The studies which are approved by the committee are carried out with the assistance of the Veterans Administration, the Armed Forces, the National Personnel Records Center of the National Archives and Records Service, and other agencies whose records are needed, as well as the various States which have jurisdiction over records at death. The MFUA provides epidemiological, statistical, and logistic competence in planning, constructing and executing studies and a unique expert experience in finding and using existing records.

Based upon the extensive experience of the MFUA, the NRC offered to assist in the investigation of the consequences to the troops which participated in the atomic tests. The problems which must be addressed are twofold: One, the identification of individuals who have developed or will later develop malignancies; and two, the statistical study of those exposed to radiation at the bomb tests to define the quantitative risks of development of malignancy and other somatic changes.

The first objective, that of finding the individuals, is an effort to which the initial epidemiological study can contribute. Once identified, they will require medical care. That endeavor, of course, will have to be dealt with primarily by medical care facilities, both public, such as Veterans Administration and so forth, and private. The National Research Council/National Academy of Sciences, of course, is not the appropriate mechanism to deal with the care of individuals who have contracted such disorders.

The second objective, the quantitative risk evaluation, is quite similar to the studies in Japan which continue to be evaluated through the advisory committee to the Radiation Effects Research Foundation—the old Atomic Bomb Casualty Commission—which have been a continuing responsibility of the National Research Council since the inception of the program. This is the area in which a major scientific contribution to medical knowledge can be developed and in which the National Academy could provide unique scientific guidance.

We envision the task to be set before us to be in three parts. First, using the military records of men who can be identified as participants in selected tests, all personnel would be traced through existing medical care and death records to identify those who contracted any malignancy especially any of the major malignancies known to be at increases risk due to radiation exposure: leukemia, thyroid cancer, lung and bone cancer.

A comparable group of unexposed military personnel would be selected as controls and would similarly be studied. This part of the study would answer two major questions: One, was presence at an atmospheric test a significant risk factor in the subsequent development of malignancy; and two, which individuals contracted a malignancy during the period from the time of the test to the present?

At this point, it must be noted that we are dealing with a single study, approximately 20 years after exposure. Because of the long latency period, to which I believe Dr. Carter has already referred, because of the long latency period for some malignancies, most, indeed, and the variable exposure dosages which can be expected, a proper study should also entail a continuing study of the exposed population for another 10 to 20 years. This continuing study could be done by the National Research Council with the assistance of the VA and the military services, much as we have done for the study in Japan.

A major problem which would place inhibitions upon this phase of the study are privacy restrictions enacted by the Congress. In order to track the living survivors of the study group, it is necessary to make personal contact with each individual to obtain information about his current medical status. The best means of obtaining current addresses of these individuals is through the Internal Revenue Service and the Social Security Administration, whose records are protected by the Internal Revenue Code and the original Social Security Act, as well as by the Privacy Act.

Some means of access to those records would be extremely useful, either through an exemption from the Internal Revenue Code for the purpose of the study or through legislative direction to the agencies to undertake the mailing of a questionnaire and a request for permission for access to medical records to be used by the National Research Council for this study.

Now, the second phase. In order to evaluate the degree of risk imposed by participation at these tests, the second part of the study would require a case by case individual study of each identified person bearing a malignancy to estimate his degree of exposure at the time of the test shot, as well as to exclude the possibility of other significant causes of malignancy, such as other radiation exposure, or occupational exposure to agents which impose a significant risk of inducing cancer. This would accomplish two things: it would refine and clarify the information acquired in the survey and it would provide a major new source of data on exposure to radiation which currently exists in volume only in the Japanese population exposed to the bombing of Hiroshima and Nagasaki.

This phase of the study would require an extensive field investigation which the National Research Council might undertake, but which perhaps preferably should be accomplished with the cooperation of the CDC and other field investigation organizations under contract.

The third phase of the study would be to correlate all of the data acquired by the first two studies with the radiation monitoring data, both personnel and environmental monitoring, which exist in the records of the Department of Energy, the Department of Defense, and the Department of Health, Education, and Welfare. This correlation and analysis could be done by the cooperative efforts of the DOE, DOD, DHEW, that is the CDC, and the National Research Council. The contribution of the National Academy of Sciences would be in providing expert scientists in the fields of epidemiology, statistical, and radiation biology drawn from the American scientific community to evaluate and analyze the data.

We estimate that the first phase of the investigation for the estimation of risk at 20 years after exposure would take at least 2 years, depending upon the numbers of military personnel to be surveyed, the nature and the character of the records of the military deployment at the test shots, and the cooperative assistance of the personnel in the VA regional offices and the state vital statistics offices.

The next two phases would require time for the field case studies and the analyses of these results. The period needed would depend entirely upon the number of malignancies identified in the survey and the availability of professional personnel to undertake the field work. The longer-term problem of following the exposed personnel for an additional 10 to 20 years should be seriously considered as a possible major additional scientific study.

A number of other evaluations of considerable scientific value could grow out of a study of these dimensions, if some portion of the exposed personnel would be willing to participate in such studies, which would impose no risk to them, nor any individual health benefit. A significant contribution to our scientific knowledge could be a byproduct of this investigation.

The entire study would be directed by a special expert committee of the National Academy of Sciences, composed of scientists representative of the disciplines which bear upon the issues. The staff of the National Research Council would be responsible for the collection of the data, the necessary ancillary information and the statistical studies for the use of the committee.

The study I would emphasize would be reviewed by an independent group of scientists prior to its release, as is the general procedure of the National Academy of Sciences, and this is the manner in which such studies have been undertaken in the past.

I thank the committee for this opportunity to testify before you. We will be pleased to respond to your questions.

Mr. ROGERS. Thank you very much, Dr. Putnam, for your testimony.

Dr. Carter?

Mr. CARTER. Thank you, Mr. Chairman.

I believe you stated that the largest numbers of people exposed to atomic radiation were at Hiroshima and Nagasaki in Japan.

How many of our military people and other citizens have been exposed to atomic radiation?

Mr. PUTNAM. You mean in the test shots?

Mr. CARTER. Yes, sir.

Mr. PUTNAM. I do not have a full estimate myself. I recollect the figure of the board that 3,000 individuals were exposed at a single shot at Smoky. I would have to make an off-the-cuff estimate. I know that a number of Canadian troops, as well, were exposed besides our own military.

Mr. CARTER. Smoky was just one blast and many of the soldiers who were there were exposed to six or seven different shots. In fact, it is estimated that between 300,000 to 450,000 persons, have been exposed to radiation from military atomic tests between 1945 and 1962.

Mr. PUTNAM. That would include probably the shots over the Pacific, and so forth.

Mr. CARTER. Yes. That estimate would include all tests to which our military personnel and others have been exposed.

Mr. Jablon, I realize you have done a great deal of research on the atomic bomb survivors in Hiroshima and Nagasaki. What level of radiation exposure did you use for your control group?

Mr. JOBLON. Well, we actually had, for different studies, three different controls. We controlled in the first instance by——

Mr. CARTER. I would like to know the amount, or the level of radiation which you used for your control group.

Mr. JABLON. Well, sir, two of them had none.

Mr. CARTER. Two of them had none?

Mr. JABLON. And a third control group was in the range from 0 to 9 rads with an average of about 1.5 or 2.

Mr. CARTER. It was our understanding that your control group had a level of 10 rads.

Mr. JABLON. That is incorrect, sir.

Mr. CARTER. Well, 9 rads is certainly very close to 10 rads. What are your current views on the health effects of low-level radiation?

Mr. JABLON. I do not know of any evidence that radiation effects in man are not linear all the way down to zero, and there is some evidence that, for at least some forms of cancer, it probably is.

You know, I am sure, Dr. Carter, that there has been a debate about whether there is a curvilinearity at very low doses. I do not think this has been by any means proven, and for some forms of cancer, I think it is pretty clear that it is not true.

Mr. CARTER. Some forms of cancer?

Mr. JABLON. Yes, sir.

Mr. CARTER. Which forms?

Mr. JABLON. Especially breast cancer in women.

Mr. CARTER. You think that breast cancer is not caused by radiation?

Mr. JABLON. No, sir. No, sir, that is not what I said. I think it is. I think the evidence is clear that it is. I say I think for breast cancer the evidence is especially convincing that the relationship may be linear all the way down to zero.

Mr. CARTER. For all ages?

Mr. JABLON. No, sir, not for all ages. In fact, at least in the Japanese experience, which is the one that I am the most familiar with——

Mr. CARTER. On breast cancer?

Mr. JABLON. Yes, sir.

Mr. CARTER. All right.

Mr. JABLON. No effects have yet been found in girls who were under 10 years old at the time of exposure. The relative risks were greatest in those girls who were between 10 and 19 years old who presumably had just gone through menarche, and this is a reasonable thing, because it is known that breast cancer is closely associated with hormonal status, which changes around that time. So there are important age effects there.

Mr. CARTER. What are the types of cancer which have no causal relationship to exposure to radiation?

Mr. JABLON. I would not be bold enough to say there was any form not caused.

Mr. CARTER. Is that not what you said? Some were caused and some were not?

Mr. JABLON. No, sir.

Mr. CARTER. What did you say, then?

Mr. JABLON. I said that the does effect relationship for breast cancer is pretty clearly linear all the way down to zero. For others, the evidence is not clear as to whether it is linear or not linear.

Mr. CARTER. It is not clear as to whether it is linear or not with other forms of cancer.

Mr. JABLON. All right.

Mr. CARTER. What about leukemias? Do you find an increased incidence of leukemias with exposure to radiation?

Mr. JABLON. Oh, indeed. Yes, indeed.

Mr. CARTER. What about lymphoma?

Mr. JABLON. Malignant lymphoma is increased also, not as much as leukemia, but it certainly is increased.

Mr. CARTER. It is increased by radiation?

Mr. JABLON. Yes, sir.

Mr. CARTER. That was stated by Dr. Upton, I believe, this morning.

What about the incidence of thyroid cancer?

Mr. JABLON. Thyroid cancer has been very markedly increased.

Mr. CARTER. What about multiple myeloma?

Mr. JABLON. Multiple myeloma has been increased also. Multiple myeloma, it turns out, has a longer latent period than some of the other forms of cancer, and so the evidence on multiple myeloma has only recently been coming out. But in Japan, there is now a paper in draft which will be published soon, I hope, showing that clearly.

Mr. CARTER. What about lung cancer?

Mr. JABLON. Lung cancer, as you know, is a difficult subject to study because of the very great importance of cigarette smoking in the incidence of lung cancer. In Japan, we have found an increase of lung cancer with radiation. It has been a little difficult to tease apart the relative influences of smoking and radiation in production of the increase.

Mr. CARTER. I believe that you mentioned that lung cancer increased as a result of radiation——

Mr. JABLON. I presume, yes.

Mr. CARTER. Yes, sir.

That is all that I have at this time, Mr. Chairman.

Mr. ROGERS. I just wanted to get clear in my mind how you view the shape of the dose-response curve.

Mr. JABLON. Yes, sir.

Mr. ROGERS. You said some cancer, we believe, is definitely linearly related to radiation exposure.

Mr. JABLON. I believe, yes, sir.

Mr. ROGERS. Now, what are those of the significant cancers that you have observed that appear not to be a linear function of radiation dose?

Mr. JABLON. Well, I would not say that there are any that appear not to be. There are some in which when you ask the question, is it linear or does it follow a square law, you find you just cannot distinguish between the two.

One of those in fact—I hate to get technical here—in Hiroshima and Nagasaki, there were two forms of radiation. One was the gamma radiation, which is very similar to X-ray and the other was neutrons which are much more damaging and it turns out that one of the great values of the Japanese experience is that because of the differences in bomb construction there was a substantial neutron dose in Hiroshima but almost none in Nagasaki. So this has enabled us to get something of a grip on the differences between these two.

Now, there is no doubt in the world that the leukemia response to neutron irradiation is linear. At least all of the data points we have fall as near to a straight line as you would want to see down as far as can track it, and that gets down to 15 or 20 rads.

With respect to the gamma radiation, the leukemia picture is a little cloudy. There is the suggestion of some curvature, below 100 rads. But if you try to fit a linear response model and you try to fit a curvilinear response model, you find that within the limits of statistical variability, either one of them will answer the question.

So we cannot yet decide. Now, this is obviously a very important question, not only for radiation protection but for biological mechanisms of cancer induction and I am very interested in the subject. But that is the best answer that I can give you, sir.

Mr. ROGERS. Yes. Thank you.

What agout alpha radiation?

Mr. JABLON. Well, I have very little——

Mr. ROGERS. Did you have much experience there with it?

Mr. JABLON. No, sir. I haven't had any. No alpha.

Mr. CARTER. Mr. Chairman?

Mr. ROGERS. Sir.

Mr. CARTER. If you would yield on that. Smoky was mentioned.

Mr. **Jablon**. Yes, sir.

Mr. **Carter**. Are you familiar with Smoky?

Mr. **Jablon**. Not myself. I have heard a lot of talk about it, though.

Mr. **Carter**. You have heard about it but you do not have information concerning the alpha radiation there.

Mr. **Jablon**. No, sir.

Mr. **Carter**. What do you think about the suggestion that alpha particles were in the air after the blast?

Mr. **Jablon**. I do not know. I would suppose there was some alpha.

Mr. **Carter**. What are the kinds of radiation we get from atomic explosions?

Mr. **Jablon**. You get gamma, you get betas, you get neutrons and you get alphas.

Mr. **Carter**. Alpha, beta, gamma and——

Mr. **Jablon**. Neutrons.

Mr. **Carter**. Yes. All right.

Thank you, Mr. Chairman.

Mr. **Rogers**. Now, let me just ask this last question, Mr. Jablon. Do you believe the current occupational radiation exposure standard should be tightened? What is your feeling about that?

Mr. **Jablon**. My feeling on that, sir, is that I am not competent to answer that question. I think that is a question that the public, as a whole, has got to give an answer to.

Mr. **Rogers**. Well, you have worked on these studies. I presume if we asked for your advice as an expert in the statistical effects of radiation you would know whether low-level radiation is effective or not in producing harmful effects, and whether current standards protect one.

Mr. **Jablon**. Sir, I do not think that any standards are going to protect you completely. I believe that any radiation is probably harmful.

My brand of expertise, if I have any at all, is in trying to measure just what is the risk. I have no knowledge at all about radiological procedures or what goes on in nuclear power plants or what it takes to reduce doses, and so forth.

I can say that I think all exposures should be as small as they can be, but I do not know enough about the other side of the equation to say the standards should be so much.

Mr. **Rogers**. I see. So, in other words, if we can expose people to less than 5 rems a year, it should be lowered?

Mr. **Jablon**. I would certainly agree with that.

Mr. **Carter**. Mr. Chairman?

Mr. **Rogers**. Thank you.

Yes?

Mr. **Carter**. In your control group I believe the radiation exposures were quite a bit above that.

Mr. **Jablon**. Yes, sir.

Mr. **Carter**. Up to 9?

Mr. **Jablon**. Yes, sir.

Mr. **Carter**. That is almost twice our yearly standard; is it not?

Mr. **Jablon**. Well, I can explain that in the following terms.

Mr. **Carter**. Yes.

Mr. **Jablon**. We have been analyzing in terms of the so-called linear dose response model, that is, the effect goes up stepwise with the dose.

Mr. **Carter**. Yes.

Mr. **Jablon**. Now, in the 0 to 9 rad group, the mean, the average exposure, was only a——

Mr. **Carter**. Mean and average are different, of course. The mean is the middle number, and the average is the result of the sum divided by the number of elements.

Mr. **Jablon**. Let me say the average.

Mr. **Carter**. All right.

Mr. **Jablon**. The average exposure was on the order of 2 rads, because there were many more at 0 than going up to 9. But what we want to compare them with are those with doses on the order of 100 rads, 150 rads, 200 rads.

For some of the end points, that is, some of the cancers which are relatively rare, we want to build up the numbers as well as we can, and we believe we got more precision on the test by adding these lower dose people to the control group in order to get a more stable comparison.

However, as I started to say before, we have three control groups and in the data we published—we publish it in exquisite detail—if you prefer to compare with zero rads, you can do so. If you prefer to compare with those who were not in the cities but came in later, you can do so, and we also provide comparisons with expectation at Japanese national mortality rates.

So we think we have covered it as well as we can.

Mr. **Carter**. Well, let's see. You go up to 9 rads, which is in that comparison also; do you not?

Mr. **Jablon**. Yes, sir.

Mr. **Carter**. That is just a little short of being twice the average level. You are comparing something which we, in this country, regard as causative of cancer, a level up to 9 rads a year. The current level is 5 rems.

Mr. **Jablon**. This was not per year, sir. This was a single exposure.

Mr. **Carter**. Well, a single exposure. That may be worse than if you take that dose over a period of a year.

Mr. **Jablon**. Respectfully, sir, I cannot agree that one shot of 9 is worse than 5 a year for 10 years.

Mr. **Carter**. I did not say that at all.

Mr. **Jablon**. I am sorry. I thought you did.

Mr. **Carter**. But a single exposure of 9 rads is certainly worse than 5 rads for 1 year, which is the national maximum permissible dose. It is worse to receive the total dose on just 1 day than over a period of time, I would think. Radiation may be cumulative, but some people are not sure of that.

Mr. **Jablon**. Well, Mr. Carter, if what you are trying to get me to say is that we would have been better off not to have used persons with any measurable dose at all as controls, I will agree with you.

Mr. **Carter**. I certainly think that you are right. I think you made a sad mistake when you took 9 rads as the control standard, because it is, as I said, almost twice above the permissible yearly dose.

Thank you, Mr. Chairman.

Mr. ROGERS. Actually, I guess, using averages is not very helpful; is it?

Mr. JABLON. Well, it is helpful, sir, if you believe in the linear hypothesis.

Mr. ROGERS. Well, it's kind of like, what, five of us? If five of us have $5 million but you have $4 million of it and the rest of us have a little bit and we average it all out, that average does not put us off too well.

Mr. JABLON. Well, what you say is true, sir.

Mr. ROGERS. So, for the guy who gets zapped with a lot of radiation the average may not be too helpful to give us proper results.

Mr. JABLON. May I associate to your question?

Mr. ROGERS. Surely.

Mr. JABLON. You may or may not remember that last Friday there was a meeting of a group sponsored by the Environmental Study Conference which was chaired by Dr. Karl Morgan and one of the questions that was considered was occupational standards.

Dr. Morgan made what I think is a very wise remark, and that is that the important thing is not the upper limit to which some few people may be exposed. The important thing is what is the average dose to the whole population being exposed, because if you believe in a linear response model then the total number of cancers that you produce is going to be governed by the average dose to the whole population.

Now, it is true that if this dose is distributed in very disparate ways, nothing to this persons and a lot to that, the latter person is the one who is taking all the risk. So what Dr. Morgan's point was, I think, was that what you want to do is reduce the average dose to everybody and reduce the total dose to the population as much as you can. That reduces your population risk.

On the other side of the coin, since you do not want what risk that remains to be concentrated on a few tethered goats, so to speak, at the same time you want to reduce the maximum that anybody may receive.

Mr. ROGERS. Well, isn't that really the important thing that we want to do, to make sure that the individual does not receive more than a safe amount, if possible? It is not the average that we are really trying to protect. We are trying to protect the worker who is working there as an individual, not as an average.

Mr. JABLON. That is what I am talking about, Mr. Rogers. Let me pose the following dilemma for you. Right now, the limit, as I understand it, is 5 rem. But the average is very, very much less than that.

Supposing the limit were reduced to 0.5 rem, a half-rem, and suppose everybody got that. The total dose to all the workers would be very much larger than it is now, and we would be in a worse situation.

Mr. ROGERS. Well, except some may get less than 0.5, too. It may well be that half the population would have less than the 0.5 if we make the effort.

Mr. JABLON. I do not wish to argue against reducing the 5 to 0.5, if that is feasible. I am saying you want to bring them all down.

Mr. ROGERS. Well, I think we are agreed on that.

Mr. CARTER. So you feel that if 0.5 rems becomes the standard throughout the country and all are exposed to 0.5 rems, that there would be a worse situation in terms of total exposure?

Mr. JABLON. Indeed.

Mr. CARTER. Five Rem would be 10 times worse than your 0.5 rem.

Mr. JABLON. Indeed.

Mr. CARTER. Thank you, Mr. Chairman.

Mr. ROGERS. Dr. Putnam, the subcommittee is, of course, concerned that any followup study be as free as possible from control or influence by agencies that may have some policy or litigatory interest, such as DOD or DOE. I wondered what arrangements had been thought of in the design, funding, and conduct of the study that the National Research Council believes to be necessary to assure complete independence in a followup study.

Dr. PUTNAM. It is my understanding from discussion that there may be an interagency group with a lead agency which would handle the funding to be derived from a number of Federal agencies, some of which may have a litigatory interest and others of which may have an independent interest, possibly, for example, the National Cancer Institute.

In any case, regardless of the source of funding, the objective of the Academy is to assure that there is not intervention of any Federal agency or other granting body in the operations of the committee itself.

Mr. ROGERS. Would any of the agencies have any review or final approval of the design of this study, or its conduct?

Dr. PUTNAM. It is not the practice of the Academy to give that prerogative to the agency. At the time of contract negotiation, it may be that the number of individuals who are epidemiologists, vis-a-vis statisticians, vis-a-vis hematologists and so forth, might be discussed and sometimes the distribution of specialties might even be incorporated in the contract, but the agency would not have any control over the operation of the committee itself and would certainly not have jurisdiction over it.

Mr. ROGERS. Should adequate funding be made available at the beginning, or do you believe it is better to go year by year?

Dr. PUTNAM. I think that sufficient insurance of continued funding is very important because there will be a necessity to recruit the staff to undertake a project of this magnitude.

Mr. ROGERS. Well, now, how has it been proposed that this study would be funded?

Dr. PUTNAM. I have only indirect information on that. Neither I nor Dr. Handler engages directly in contract negotiations. As I say, it is my belief that a group of Federal agencies have discussed this issue, including that meeting on December 1, and that the funding would be from a variety of Federal sources, including agencies other than Department of Defense and so forth, but would be going to a lead agency, possibly—is it Nuclear Regulatory Commission? Excuse me. The Armed Forces Radiobiology Research Institute.

Mr. ROGERS. So DOD would be the lead agency?

Mr. WEISS. The discussions thus far have pointed to the Armed Forces Radiobiology Research Institute as the NRC's contact with the interagency committee.

Mr. ROGERS. I wonder if it would be well for the Academy, and those of you involved, to give us your thinking as to whether an act of Congress specifically authorizing and specifically funding such a study would be a better approach than depending on agency funding.

Mr. WEISS. I understand, Mr. Rogers, that when an act of Congress authorizes a study of this nature and funds it, or directs the funding of it, that it names some agency to do so, and it is of no consequence to the National Academy who the point man is.

Mr. ROGERS. In fact, I think we have funded some studies even with the cooperation of the National Academy of Science President.

Mr. WEISS. Several times.

Mr. ROGERS. That is what I was thinking.

Would you be prepared to support such a recommendation?

Dr. PUTNAM. I think I would have to consult with Dr. Handler about the direct question of supporting such legislation. Clearly, it is of value to us to have an independent source of funding to assure the greatest possible objectivity and least possible attempted interference. There is, of course, a question of time lag for the legislation.

Mr. ROGERS. Well, that is true. Of course, we have already waited about 20 years, so I am not sure that a few months more would make that much difference.

Let me ask this—excuse me, Dr. Carter?

Mr. CARTER. Mr. Chairman, it is more like 30 years, if you will excuse me.

Mr. ROGERS. I do not guess it would be too much, because you would be working on your study design anyhow, would you not? Wouldn't it take some time to get set up?

Now, how would you select the particular bomb explosion projects to study?

Dr. PUTNAM. It is my understanding that the greatest information is currently available about operation Smoky, and I believe that is considered to be the dirtiest of the operations, in terms of the total exposure of individuals and that alone, with some 3,000 troops, as well as other non-U.S. observers involved would be a project of some magnitude.

I think that the selection of the projects or the shots would, in part, depend upon the availability of information about personnel exposed and military records and other information of that type that would assure a valid, objective study.

Mr. ROGERS. We understand that there were some dirtier than Smoky. For instance, Nancy, I think, was one. Unfortunately, there they did not have badge records. And I think it was two times the explosive force, as thereabouts. I believe it was 177 kilotons, whereas Smoky, I think, was about 48 or 44.

Mr. CARTER. It was supposed to be 44, but actually it was 48.

Dr. PUTNAM. Well, clearly, this is an area that the committee itself would have to review carefully at the time that the design of the study is proposed and developed, together with the contract agency of the Government.

Mr. ROGERS. In other words, what we were concerned with was that you would not just use the more controlled studies, because there were many that were not——

Mr. CARTER. Mr. Chairman, I believe that the dirtiest explosion in the United States was at Hood, in 1957: 77 kilotons, 2,100 marines.

Dr. PUTNAM. Oh, yes.

Mr. CARTER. Do you think we will have trouble finding the names of those marines?

Dr. PUTNAM. I think that Mr. Jablon can advise me better about the difficulty of finding records of various service agencies. I think that the Marines might be easier to follow up than some of the other Armed Forces.

Mr. CARTER. I would hope so, because the retrieval of these names has been a disaster of the greatest magnitude.

Mr. JABLON. If you are requiring a further response to the question, I would say that it seems to me that there are a number of considerations which would enter into picking shots. One you have mentioned, and that is the reputation of this or that shot, or the evidence that this or that shot, was an especially dirty one.

A second consideration is the quality of the records of the people who were there. I have not had the opportunity to examine any of these. I have heard stories to the effect that some of the records from shots 25 years ago are in terrible condition, and it may be very difficult, at this time, to identify who was there. I think the first job we would have to do, even before designing the study, would be to go over the series of shots, classifying them according to their cleanliness scale, if I may speak so, and examining the quality of the records of units who were there to see what can be done.

It may be, it may be, that there will be some for which the records are just gone and you cannot tell who was there. And if we put all of this together, presumably the committee to which Dr. Putnam referred will be able to choose wisely.

Mr. CARTER. Mr. Chairman?

Mr. ROGERS. Yes, Dr. Carter.

Mr. CARTER. On that, it is true that some of the shots go back even further than 25 years, actually 35 years, to be exact. There is some very interesting information about those, too, that may or may not be available to you, or which some people have not made available but, nevertheless, have become available to some of us.

Are you familiar with Rotblatt's study of early entrants into Hiroshima?

Mr. JABLON. Yes, sir, I did read it.

Mr. CARTER. Can you give an opinion about that study?

Mr. JABLON. Well, I can give the same opinion that Professor Rotblatt gave at the Windscale hearings last fall, and that was that he thought that the data which he had obtained, which had been previously published by Dr. Hirose and Dr. Watanabe of the Nuclear Research Institute in Hiroshima were very provocative and certainly merited further investigation. I can go no further than that.

Mr. CARTER. You can only say that they were provocative?

Mr. JABLON. Yes, sir.

Mr. **Carter**. Didn't they show an increased incidence of leukemia?

Mr. **Jablon**. Well, they apparently showed an increase in incidence.

Mr. **Carter**. Apparently?

Mr. **Jablon**. Apparently, yes, sir.

Mr. **Carter**. Apparently. I think, as we go along, it will become more apparent.

Thank you, Mr. Chairman.

Mr. **Rogers**. Thank you.

What, Dr. Putnam, is the relationship between the National Research Council and the Radiation Effects Research Foundation?

Dr. **Putnam**. The Radiation Effects Research Foundation is actually operated through the National Research Council and indeed, through the Assembly of Life Sciences, of which I am chairman, and is directly under the supervision of Dr. Councilman Morgan, who is on the board of the RERF.

Would you like to respond further?

Dr. **Morgan**. Well, this was set up about 3 years ago. It is a binational foundation, the Radiation Effects Research Foundation. Fifty percent of the funding is by the United States and 50 percent by Japan. The money comes largely from the Department of Energy. Our funding approximates $6 million a year. Some additional funds are provided by NCI and NHLBI. It is passed through the National Academy of Science. It does not originate there, but it is a passthrough fund.

We are responsible for the scientific programs of the Foundation, for overseeing their excellence, for assisting in scientific staffing, in attracting Americans and Japanese scientists of high quality to work there. That is the arrangement at the moment.

Mr. **Rogers**. Do any of the DOD personnel serve the Radiation Effects Research Foundation or its advisory committee in any capacity.

Dr. **Morgan**. There is nobody from DOD. Dr. Liverman, from the DOE is one of the American directors, of the Foundation. There are an equal number of Japanese directors and American directors and each has one vote. The scientific guidance is provided by a committee of the National Academy of Science, selected, by the Academy, not by DOE.

Mr. **Rogers**. And what about the input from Japan?

Dr. **Morgan**. The Japanese have a like system. They nominate, or choose, their directors, which, as I said, are 50 percent of the directorship. At present, the Chairman of the Foundation is Japanese. The Vice Chairman and the Chief of Research, which are the next two top positions, are both Americans.

Mr. **Rogers**. And what is the funding from Japan, if any?

Dr. **Morgan**. Japan puts the same amount that we put in, namely, the equivalent of $6 million comes from Japan.

Mr. **Rogers**. And it is this foundation that is continuing the studies on the health effects?

Dr. **Morgan**. Yes, and it has two bases, one at Hiroshima and one at Nagasaki where the two bombs were dropped.

Mr. ROGERS. I think it would be helpful if you could let us have, for the record, the Academy of the Life Sciences, or the NRC's, recommendation on separate legislation to fund this study.

Dr. PUTNAM. We would certainly get information on that for the record.

Mr. ROGERS. That would be helpful.

I presume we could have the recommendation fairly soon, could we not?

Dr. PUTNAM. We will assure that.

[The following letter and suggested draft language were received for the record:]

NATIONAL ACADEMY OF SCIENCES

OFFICE OF THE PRESIDENT
2101 CONSTITUTION AVENUE
WASHINGTON, D.C. 20418

March 21, 1978

The Honorable Paul G. Rogers
House of Representatives
Washington, D. C. 20515

Dear Mr. Rogers:

I am writing to follow-up our conversation of February 23, on how the National Academy of Sciences might cooperate with the U.S. government in studies on the health effects of exposure of U.S. military and civilian personnel at nuclear weapons tests. This letter also is responsive to your earlier request made to Dr. Frank W. Putnam, Chairman of the National Research Council's Assembly of Life Sciences, at the February 14 hearings of your Subcommittee on Health and Environment on the health effects of low-level ionizing radiation. At the hearings you requested our suggestions for proposed legislation to authorize such studies by the Academy. The enclosed is a suggested draft language response to your request; if enacted, the study would be carried out in the manner described by Dr. Putnam in his testimony to your Committee.

As you know, the Academy also has before it for consideration requests from the Department of Defense and the Department of Energy that we undertake related studies. While the study scope has been broadened as a result of the information presented at your oversight hearings, the subject content and the scientific issues to be addressed remain the same. As I indicated in my conversation with you, my view is that the Academy should proceed with negotiations currently under way with the Executive Branch so that the initial phases of such studies can get under way immediately, pending the enactment of legislation authorizing the longer term study.

These interim initiatives will be especially useful in allowing us to make an immediate start towards developing a detailed understanding of the physical characteristics of the various tests, the comprehensiveness and availability of the monitoring data, and the nature and completeness of the lists of observers and participants at the tests, both military and civilian. With this information, we can then proceed to develop a definitive plan of action for the longer term aspects of the study. It is these preliminary steps which we hope to get under way as soon as possible.

The information presented to date concerning medical problems of observers of atomic bomb tests, the likely variations in radiation dosages, and the long latency period associated with some malignancies provide a persuasive basis for anticipating a continuing scientific study of the exposed population for upwards of twenty years. To assure continuation of such a study to its conclusion, legislative commitment to long-term support and to an appropriate institutional framework seems justified. In fact, I would be hesitant for the National Academy of Sciences to undertake such a long-term study without some form of legislative commitment and endorsement of the program.

The enclosed suggested draft language is only one of many forms in which such a statutory study could be framed and modification of this format may be needed to conform the language to the legislative manner in which you may wish to consider such a measure. You will note that provision is made in the draft to facilitate the task of collecting information needed to locate and contact affected individuals. I am advised that exclusion from the privacy provision of the Internal Revenue Code and the Privacy Act would greatly expedite this task. As drafted, it would hold the Secretary of Health, Education, and Welfare responsible for making the study arrangements and would embody the intent for a long-term study. The draft would include within the study both military and civilian personnel involved in such tests, recognizing, however, that the form and manner in which coverage of affected civilians is to be handled will be an especially difficult task. The language generally conforms to wording used in other statutes that have authorized studies by the National Academy of Sciences on behalf of the government.

In view of the urgency in responding to the several requests for Academy cooperation, I have presented the proposition for a study to the Governing Board of the National Research Council, which met on February 25, and have received their concurrence to cooperate with the Federal government in such an undertaking.

After you have reviewed this suggested draft language, please let me know if we can be of additional assistance. My staff also are available for further consultation on the details for such a study.

Sincerely yours,

P Handler

Philip Handler
President

Enclosure

A BILL

To provide for studies on the health effects of exposure to radiation from nuclear weapons tests.

Section 1.

The Secretary of Health, Education, and Welfare (hereinafter referred to as the Secretary), in cooperation with the Secretary of Defense and the Secretary of Energy, shall arrange for the conduct of epidemiological and other studies in connection with United States military personnel and other persons exposed to radiation from atmospheric level tests of nuclear weapons carried out under the jurisdiction of the United States government.

Section 2.

The studies required by Section 1 shall be the subject of an annual report by the Secretary, to be submitted no later than July 1 of each year to the President of the U.S. Senate and the Speaker of the U.S. House of Representatives, including information regarding the status of the contractual arrangements for such studies and any condition necessary to implement these provisions.

Section 3.

(a) The Secretary shall request the National Academy of Sciences to conduct such studies under an arrangement whereby the expenses incurred by the Academy in conducting such studies will be paid by the Secretary. The studies undertaken by the Academy shall include but not be limited to (1) identification of individuals who have participated in such tests and estimation of their exposure to radiation, (2) investigation of the consequences to such individuals of their exposure to radiation, and (3) performance of appropriate studies of those exposed to radiation as a basis for defining the quantitative risks of development of malignancy or other somatic changes. If the National Academy of Sciences is willing to do so, the Secretary shall enter into such an arrangement with the Academy for the conduct of such studies.

(b) If the National Academy of Sciences is unwilling to conduct the studies required under this section, under such an arrangement with the Secretary, then the Secretary shall enter into a similar arrangement with other appropriate nonprofit private groups or associations under which such groups or associations shall conduct such studies as provided in Section 1.

Section 4.

The Secretary and other Federal agencies shall furnish to the organization performing the studies authorized by Section 1, at the latter's request, any available information which the performing organization may deem necessary for the purpose of conducting such studies. Such information shall be provided on a confidential basis and without regard to 5 USC 552a or 26 USC 6103.

Section 5.

In entering into any arrangement for the conduct of such studies, the Secretary shall request the performing organization to report annually to the Secretary on its studies and investigations; such report is to be transmitted with the Secretary's annual report to the Congress each July 1.

Section 6.

The Secretary shall support such studies for as long as necessary to ensure that such studies are consistent with the long latency period between exposure to radiation and manifestation of possible malignancies. There are authorized to be appropriated such funds as may be required for the conduct of the studies authorized by Section 1.

Mr. ROGERS. Thank you.

Thank you for your presence and for your help. The committee is most grateful.

The next witnesses will come from the Department of Defense, Vice Adm. Robert R. Monroe, U.S. Navy, Director of the Defense Nuclear Agency. I believe he is accompanied by Mr. Peter Haas, who is Deputy Director for Science and Technology, Defense Nuclear Agency; and Maj. Alan Skerker, member of the Nuclear Division, Strategy, Plans and Policy Directorate, Office of the Deputy Chief of Staff, U.S. Army.

On behalf of the Army, Col. Victor Hugo. On behalf of the Air Force, Lt. Col. George Kush. On behalf of the Navy, Comdr. Milton Finkelstein. On behalf of the Marine Corps, Maj. Rafael Negron.

We welcome all of you gentlemen to the committee and Admiral, your statement will be made a part of the record, without objection, and you may proceed as you desire.

STATEMENTS OF VICE ADM. ROBERT R. MONROE, USN DIRECTOR, DEFENSE NUCLEAR AGENCY, ON BEHALF OF SECRETARY, DEPARTMENT OF DEFENSE; COL. VICTOR J. HUGO (ARMY); COMDR. MILTON M. FINKELSTEIN (NAVY); LT. COL. GEORGE S. KUSH (AIR FORCE); AND MAJ. RAFAEL NEGRON (MARINE CORPS), ACCOMPANIED BY CAPT. PAUL TYLER, MEDICAL CORPS (NAVY), DEPUTY DIRECTOR OF THE ARMED FORCES RADIOBIOLOGY RESEARCH INSTITUTE; PETER H. HAAS, DEPUTY DIRECTOR, SCIENCE AND TECHNOLOGY, DEFENSE NUCLEAR AGENCY; MAJ. ALAN SKERKER, MEMBER, NUCLEAR OFFICE OF THE DEPUTY CHIEF OF STAFF, OPERATIONS AND PLANS (ARMY); AND REAR ADM. HENRY A. SPARKS, M.D., ASSISTANT CHIEF OF MEDICAL SUPPORT, BUREAU OF MEDICINE AND SURGERY (NAVY).

Admiral MONROE. Thank you, Mr. Chairman.

I am Vice Admiral Monroe, Director of the Defense Nuclear Agency. It is a great privilege to be here today, as a representative of the Secretary of Defense, to provide this committee with a summary of actions now underway in the Department of Defense to develop data on DOD personnel who participated in atmospheric nuclear weapons testing.

Accompanying me today are Capt. Paul Tyler, Medical Corps, U.S. Navy, the Deputy Director of the Armed Forces Radiobiology Research Institute, and representatives of the four military services: Col. Victor Hugo of the Army; Comdr. Milton Finkelstein of the Navy; Maj. Rafael Negron of the Marine Corps; and Lt. Col. George Kush of the Air Force.

Mr. ROGERS. We welcome all of you gentlemen.

Admiral MONROE. Also present, in response to the Committee's request of February 1, are Mr. Peter Haas, my Deputy Director for Science and Technology, and Maj. Alan Skerker of the Army, who appeared before you earlier.

Mr. ROGERS. Yes. We welcome you gentlemen back.

Admiral MONROE. Since the representatives of the Department of Defense last appeared before you on January 25, the Secretary of Defense has initiated a major program to develop information on the participation of DOD personnel, both military and civilian, in atmospheric nuclear weapons testing. The Defense Nuclear Agency has been designated the DOD executive agent for this program, and I would like to summarize for you its scope and breadth.

Through extensive research efforts by the four military services, we expect to do the following, to the extent that records are available:

First, to develop a history of every atmospheric nuclear test that involved DOD personnel, military or civilian.

Second, to identify the radiation monitoring control policies, procedures and requirements that were in effect.

Third, to assemble a census of personnel at each test or test series, identifying their location and movements during the event, their protection, and their radiation dose exposure.

Results of this research will be made available as soon as developed, to scientific review organizations—the Center for Disease Control, the National Research Council of the National Academy of Sciences, or others—for studies investigating the risks of exposure to low-level ionizing radiation.

As our research progresses, and individuals are identified whose recorded exposure to radiation is above a given level, DOD will attempt to locate and notify them and initiate appropriate medical follow-up.

Now, the Defense Nuclear Agency is responsible for the overall program within the Department of Defense, and is providing the centralized direction and control. This operation is centered at the Armed Forces Radiobiology Research Institute—AFRRI—a subordinate command of DNA. We presently have 35 individuals working full time on this DNA portion of the effort.

The detailed research will be accomplished by the four military services, each handling its own units and personnel. I would like to emphasize for a moment the extensive nature of the research effort we have embarked upon. As you know, we are dealing with events that occurred 20 to 30 years ago, with records that are incomplete and scattered.

I cannot give you a firm schedule at this time, as the exact magnitude of the task is unknown. It will surely require many months, possibly several years, to complete; however, segments of the data will become available relatively soon. We are prioritizing the research, so as to focus initially on those events of the greatest medical or scientific interest or concern.

The number of individuals that are devoted to this research by each of the services will vary, depending on the magnitude of the task. For example, the preliminary data from Exercise Desert Rock VII and VIII indicate that over 5,000 Army troops and some 3,600 marines were involved, while the Air Force had only about 240 and the Navy less then 100. On the other hand, the Navy was extensively involved in all the Pacific tests.

Thus, the manpower, the expense, and the time required for each service's research will vary widely.

Representatives of each of these services, whom I introduced, will be prepared at the conclusion of my statement to give you brief descriptions of the efforts now getting underway in their services.

To assist in gathering as much information as possible, we have installed toll-free telephone lines at AFRRI—the Armed Forces

Radiobiology Research Institute—initially two lines, now six lines. We have widely publicized these numbers requesting DOD individuals who have participated in nuclear weapons tests to call and provide us key items of information on their involvement as well as up-to-date locators.

Nationwide response has been intense, with about 2,500 calls having been received in the first 5 days of operation. These telephones are currently being manned on a round-the-clock basis, 7 days a week.

We are also conducting a major effort to declassify all possible documents regarding participation of DOD personnel in atmospheric nuclear tests. Already, some 20 reports on the Desert Rock series have been declassified. Copies have been provided the committee as requested by your letter of January 19.

In closing, Mr. Chairman, I would like to express my appreciation for this opportunity to outline for you today the Department of Defense program. I can assure you that this effort is receiving high-level attention in DOD and that there is total commitment to carry it through thoroughly and quickly.

We feel a deep sense of responsibility toward the Department of Defense personnel involved, to insure that any possible relationship between exposure to nuclear weapons tests and subsequent incidence of leukemia or other cancers is investigated; and we see an opportunity to assist in making a significant contribution to scientific knowledge on the health effects of ionizing radiation. We will keep the committee fully informed of our progress.

Mr. Chairman, this completes my statement. The service representatives are now prepared to give you a brief summary of their research plans; after which we will be pleased to answer any questions which you may have.

Mr. ROGERS. Thank you, Admiral. I think that would be helpful, if we could have a quick statement from each of the services.

Admiral MONROE. Thank you, sir.

STATEMENT OF COL. VICTOR J. HUGO

Colonel HUGO. Mr. Chairman, I am Colonel Hugo. I am currently assigned to the Office of the Chief of Staff of the Army and I have been designated as the focal point within the Army to coordinate the efforts of that service in developing the names of the particular individuals who were present at nuclear weapons testing.

I am assisted, at the moment, by three additional personnel within the Office of the Chief of Staff of the Army who are employed currently full time. They are Lieutenant Colonel McCafferty, Major Skerker, whom I believe you know and who has been here previously, and Major Deline. In addition to that, sir, I also have two full-time administrative personnel who are assisting me.

Currently within the Army staff in the Army Secretariat are an additional five personnel who are currently devoting approximately 50 percent and more of their effort. I have these names if you so wish, sir.

Mr. ROGERS. I think it would be helpful, for the record.

Colonel HUGO. All right, sir.

Mr. ROGERS. You can submit them for the record.

Colonel HUGO. Fine, sir. I will submit them later for the record.

[The following material was received for the record:]

ADDITIONAL ARMY STAFF IN THE ARMY SECRETARIAT

Army personnel presently devoting approximately 50 percent or more of their effort to matters related to nuclear weapon atmospheric testing: Col. T. Nowosiwsky, Col. V. Miller, Maj. D. Keller, Mr. W. Anderson, and Mr. P. Feagles.

In addition to these five and to the five full-time personnel previously mentioned, the Army currently has 31 other administrative personnel working primarily on this program.

Colonel HUGO. Probably the most important individual we have is Mr. Anderson from the Army Office of the Adjutant General. He is the one who will be most responsible for helping us develop the names of the individuals who were involved in this testing.

Since Major Skerker appeared before you in the latter part of January, I would like to summarize briefly, if I may, the efforts that the Army has undertaken to cooperate with the efforts of the Defense Nuclear Agency and the committee.

Mr. ROGERS. That would be helpful.

Colonel HUGO. We have, of course, reviewed and declassified the reports for which the Army has been the proponent, and I believe that these have already been provided for the subcommittee; prepared responses to the questions that the subcommittee submitted to Major Skerker subsequent to his testimony toward the latter part of January. We have initiated an intensive data review, not only reviewing the data which has been made available to us by the Defense Nuclear Agency, but also contacting other Government agencies which we believe may have records and reports which would be of assistance to us in developing the names of all the total participants; begun preparation of the report to which Admiral Monroe referred earlier; and, I think most importantly, have established liaison with the Office of the Adjutant General and the Surgeon General to assist in identifying these people.

If I may, I would like to, very briefly, explain why this is going to be a very time-consuming task.

Mr. ROGERS. Yes.

Colonel HUGO. I think first of all, and I believe Dr. Carter mentioned the fact about the records and how difficult it was going to be to get the information necessary. There are several reasons that account for this difficulty in trying to achieve it.

First of all, the fact that Camp Desert Rock, which is the name of the particular series of tests which the Army is most interested in at this moment, because that has the most substantial troop involvement insofar as the Army is concerned, Camp Desert Rock was, in and of itself, a provisional organization. It was a subpost of Camp Irwin, and as such, really had no permanently assigned personnel.

The Army units, even, that participated in the tests were not exactly a table of organization and equipment units, that is, with a set organization that came from a set post. In many instances, they were composed of individuals who were sent to a particular organization by another post. So we have a very difficult time trying to reconstruct and arrange rosters of the individuals that were assigned to a particular unit during a particular test. We can do it. It is going to take us time, however, to do so.

Mr. ROGERS. May I ask, do you have a record of the serial numbers of those men?

Colonel HUGO. Yes, sir. What we would have to do, sir, is to go back and screen all the morning reports, some 12 million frames of microfilm, I am given to understand, and piece together, step by step, during a particular time frame the individuals assigned to this particular organization that appeared during the testing of the particular record.

Mr. ROGERS. Yes, sir, Dr. Carter.

Mr. CARTER. On that, it seems to me that there would be a special order for these men, listed by name. Do you remember when you were ordered to one part of the country——

Colonel HUGO. Yes, sir.

Mr. CARTER. It does not seem to me that you would have to get the morning reports and screen them. There must have been a special order written, it seems to me, for every man who went out there.

Colonel HUGO. Well, yes, sir, except it could very well have been a company or a particular unit just sent on that particular order. In other words, there are, for example, 20 people from, for example, Fort Bliss, or 20 additional personnel from Fort Hood, may have gone and comprised the unit at the test site itself.

Mr. CARTER. Well, those names must be listed as a group somewhere. You just do not send 20 men to a test site without their names, rank, and serial number kept on file somewhere.

Colonel HUGO. Yes, sir. Yes, sir, they are down, and that is what we will have to do, is screen those records.

Mr. CARTER. All right, sir.

Thank you, Mr. Chairman.

Mr. ROGERS. Do I understand you to say that Camp Desert Rock, had no set of orders in your records as to who participated in the nuclear bomb test operations?

Colonel HUGO. No, sir. What I am saying, sir, is that there were sets of orders on the particular units and on the particular individuals that were involved. These particular records would have been entered into morning report files, which are filed in that particular order.

Mr. ROGERS. Do you mean you do not have the orders together for the headquarters there? Do they keep the records of those orders?

Colonel HUGO. Yes, sir, we keep the records.

Mr. ROGERS. Do you keep the personnel records of those men and their serial numbers?

Colonel HUGO. Not quite that neatly, sir.

Mr. ROGERS. What's that?

Colonel HUGO. Not quite as neatly as what you would think, no, sir. No, sir, we do not.

Mr. CARTER. What about copies of the 201 files that you have?

Colonel HUGO. Sir, the copies of the 201 files—if I may for just a moment, once we have constructed rosters of the units that would be involved in the tests, and this would be based on morning reports plus the orders to which you referred, Dr. Carter, we would construct the rosters of the individuals that were assigned to the units that participated in the tests and we would then go to a separate set of files to come up with the individual's personnel records, which would include his medical records.

Now, part of the difficulties that we are going to encounter—and it is not only the Army, but all of the other services as well—is the fact that the period that we have under investigation, or under scrutiny, up to 1958, I am led to understand that approximately 80 percent of the records that are involved in that particular period were destroyed in the fire in the GSA records holding facility, sir.

So we are going to have trouble identifying the precise radiation dose, looking at the personnel records—

Mr. ROGERS. When was that?

Colonel HUGO. I believe 1963, sir, but I will find out and submit that for the record for you.

Admiral MONROE. I can comment on that, Mr. Chairman. The fire was in July 1973. It destroyed some 17 million service records, including those of Army personnel who were discharged up through December of 1959, and Air Force or Army Air Corps personnel who were discharged up to December of 1963. One entire floor of the building, with 17 million records, was lost.

Mr. ROGERS. Did you lose the records of the various headquarters, or were these just individual files?

Colonel HUGO. I am led to understand, sir, that they are just individual files.

Mr. ROGERS. So you should still have the records of Camp Desert Rock——

Colonel HUGO. Of the Headquarters.

Mr. ROGERS. Of who was there, the orders issued, the orders they received?

Colonel HUGO. Yes, sir. We would have the morning report entries from Camp Desert Rock, yes, sir, that we could reconstruct the rosters. But, of course, that would not then give us the radiation dose that the individuals may have received.

Mr. CARTER. Mr. Chairman, on that, if you would yield, I believe most of those dosimetry reports are at Blue Grass Ordinance Depot, are they not?

Colonel HUGO. Some of them are, sir. Some of them, for example, from 1957, the Lexington Army Signal Depot did, in fact, develop and has a film reel, for example, of the radiation records from 1957. In the intervening years, from 1953, 1955 and 1956, many of the film badges were developed at Camp Desert Rock, radiation data extracted, and sent to the individual's home station for inclusion in his medical file. These medical files, are, of course, as I mentioned, included in the individual's personnel records, some 80 percent of which could well have been destroyed in this fire, in 1973, sir.

Mr. ROGERS. Thank you, Colonel Hugo.

Admiral MONROE. Comdr. Milton Finkelstein of the Navy.

STATEMENT OF COMDR. MILTON M. FINKELSTEIN

Commander FINKELSTEIN. Mr. Chairman, I am Milton M. Finkelstein, a commander in the Navy, serving in the Office of the Chief of Naval Operations. I also have been identified as a focal point for my service.

The Navy goal in support of the DOD-directed effort is to identify an estimated 100,000 Navy individuals, military and civilian, who participated in the atmospheric nuclear test program. The identification process will include determination of the names of the individuals who participated in the tests, their identification number, date and place of birth, home of record at the time of service entry, documented exposure data, documented test participation and last known address.

A pilot staff, comprised of 6 officers on a full-time basis, about 20 others on a part-time basis, and a number of organizations are providing support to this effort during the interim period until the dedicated project office is fully staffed.

Research of technical reports establishing postevent radiation contours of participating units, safety indoctrination, monitoring procedures and location of units during the detonation phase is being performed by the Navy's technical laboratories and facilities. An example of the results to date include the statistics on Operation Crossroads conducted at Bikini during July 1946. This two-event operation included approximately 42,000 men, 242 ships and 156 airplanes.

A search and review of archived unit documents to establish names of participating individuals is being conducted by the Bureau of Naval Personnel for military personnel and the Office of Civilian Personnel for Navy civilian participation.

The principal locations of these historical documents are the GSA-managed Federal Records Centers at both Suitland, Md., and St. Louis, Mo. The census of identified Navy participants in operation crossroads to date is 1,038 names.

A parallel search for dosimetry data will be conducted by the Bureau of Medicine and Surgery. This effort involves reviewing Navy health records for exposure information and corroborating the data with that contained in the Department of Energy's contractor's dosimetry system. Liaison has been established with the Department of Energy and other military services to insure that applicable dosimetry records are identified. We estimate that it will require at least 20 man-years of effort to review the participant medical records at the Department Medical Center in St. Louis and the Department of Energy's Operation Office in Las Vegas.

The initial efort to collect the dosimetry information should be completed within 2 years with the end product being identification of participating individuals and their total radiation exposure. After the initial effort, it is estimated that a small staff will be required to search personnel and dosimetry records in response to individual inquiries.

Mr. Chairman, that concludes my remarks.

Mr. ROGERS. So you have 6 officers and 20 others part time?

Commander FINKELSTEIN. Yes, sir.

Mr. ROGERS. How much of their time are they devoting?

Commander FINKELSTEIN. The six officers are devoting full time.

Mr. ROGERS. Full time.

Commander FINKELSTEIN. Yes, sir.

The 20 personnel are probably devoting about 50 percent of their time at this time.

Mr. **Rogers**. Would you let us have their names for the record?

Commander **Finkelstein**. Yes, sir, for the record, we will provide that.

[The following information was received for the record:]

U.S. Navy Atmospheric Nuclear Testing Program

Full time:

Capt. T. H. Sherman, USN, Cmdr. M. M. Finkelstein, USN, Lt. Comd. R. T. Bell, MSC, USN, Mr. E. Haslam, Mr. H. Ottenstroer, Mr. R. Luersen, YNSN S. Cross, USN.

Part time:

Capt. D. Henderson, USN, Capt. G. Tsantes, USN, Capt. J. Mahaffey, USN, Comdr. W. M. Beckner, MSC, USN, Lt. Comdr. L. Beuchler, MSC, USN, Lt. Comdr. S. Turner, USN, Lt. Comdr. D. Brown, MSC, USN, Lt. Comdr. W. H. Vernon, USN, Lt. W. R. Wedding, MSC, USN, Lt. J. Graham, JAGC, USN, HMCM C. P. Cobbs, USN, YN1 E. C. Umali, USN, Dr. D. Allard, Mr. P. Crowley, Mr. R. Jenkins, Mr. R. Hammond, Mr. L. Thomson, Ms. Thomas, Mrs. D. Powell, Mrs. C. Melito, and Ms. M. Harrington.

Mr. **Rogers**. And would——

Commander **Finkelstein**. There are numerous other individiuals unaccountable, actually, in the organization throughout the Navy to do this.

Mr. **Rogers**. Any names of the people working on this and the amount of time they are devoting to this would be helpful.

May I ask the Colonel one question? How many records are you having to look for in the Army?

Colonel **Hugo**. On the Desert Rock series alone, sir, we are estimating in the vicinity of 80,000.

Mr. **Rogers**. And what others?

Colonel **Hugo**. Well, sir, then we will look at the series that were run in the Pacific during the late 1940's. But we are concentrating our efforts at the moment on the Desert Rock series.

Mr. **Rogers**. How many do you estimate in the Pacific?

Colonel **Hugo**. I would say approximately 40,000 to 50,000, sir, is what we are looking at.

Mr. **Rogers**. Thank you.

Mr. **Carter**. Mr. Chairman, on this, I find it rather interesting—the following procedures were described in the Exercise Desert Rock VII and VIII, "Final Report of Operations", for controlling convoys in the forward areas.

[The following report was received for the record:]

ANNEX I (UNCLASSIFIED)

STANDARD OBSERVER GROUPING, ROSTERING AND CONVOY PROCEDURES FOR CAMP DESERT ROCK

1. ROSTERING

a. Staff supervision of grouping and rostering observers was considered a dual responsibility of S-2 and S-3. S-2 was responsible that all rostered observers had the proper security clearance. S-3 was responsible that all properly cleared observers were grouped and rostered to see a shot.

b. The following procedure was found to be the most effective:

(1) Prior to arrival of observers, S-3 estimated the number of briefing groups required and the anticipated vehicle requirements for each shot, provided S-2 with a break-out of convoy serials to include respective vehicle numbers and capacities. The size of the briefing or orientation groups was dictated by the seating capacity (600) of the auditorium and the size of training aids being used.

(2) From this information, S-2 prepared security identification cards with space for observer's signature, briefing group number and vehicle number. Cards were filed in vehicle order.

(3) As observers reported, they were initially processed through Visitors Bureau and into S-2 office. Each observer gave S-2 an official copy of his orders and signed his identification card with grouping and vehicle numbers.

(4) The orders were filed in vehicle bundles, from which stenciled rosters were prepared with escort officer's name added. Stencils were proofed and certified by S-2 to insure proper clearance. Approximately eight copies of each roster were needed for each convoy movement into the Nevada Test Site.

(5) In the event it was necessary to re-roster for special situations, observers were re-routed through S-2.

2. CONVOY PROCEDURES: A physical check of personnel in each convoy moving into and out of the Nevada Test Site was accomplished by the Camp Mercury Security personnel.

a. To save time and avoid congestion at the entrance to the Test Site, DOD personnel adopted the practice of checking the convoys at Camp Desert Rock and escorting them through gates 1 and 2 at Camp Mercury.

b. The following procedures were found to be most effective in controlling convoys to the forward area:

(1) Five copies of all rosters were required to be turned in to DOD Security a minimum of six hours prior to the departure of the convoy.

(2) Vehicles were spotted in convoy order with ten by ten inch signs A-1, A-2, etc., taped in the right front windshield of each vehicle. Designated escort officers for each vehicle were briefed thirty minutes prior to loading time and given two copies of the vehicle roster.

(3) As observers loaded, each Escort Officer checked off individual names. At the announced time, Escort Officers red lined names of absentees on both copies of the rosters. Since no changes could be made on the rosters, anyone arriving after this time could not go with the convoy. Escort Officers added names of drivers (who were all badged) and entered the total number present on the two rosters.

(4) As the DOD Security representative came by to check the bus, one copy of the roster was presented to him, and the other copy was retained by the Escort Officer until his return from the forward area and then turned over to S-3 as a permanent record.

(5) In case of vehicle breakdowns, personnel could be loaded into a spare vehicle by merely exchanging vehicle numbers. Vehicle loads could also be consolidated by grouping rosters and vehicle numbers on the one vehicle being used for consolidation.

Mr. CARTER. I want to know, Mr. Chairman, what has become of all of these rosters after all of these checks? Where are they? They could not have all burned up out there in St. Louis. And you tell me it is going to take aobut 20 years, to find them all? Twenty man-years?

Commander FINKELSTEIN. Sir, I am talking 20 years of reviewing the medical records for the Navy—20 man-years, not 20 years.

Mr. CARTER. Twenty man-years?

Commander FINKELSTEIN. Yes, sir. If we are provided with the right amount of men, then we can get it done quicker.

Mr. CARTER. Well, now, you did not mention anything about this a little while ago. You brought up morning reports.

You gentlemen know better than that. Uncle Sam gave you the title of gentlemen, and I believe you are all gentlemen. Surely you can find those rosters. Clearly this is a part of your orders out there. What has become of those rosters? I want to know.

Admiral, could you answer it?

Admiral MONROE. Our research efforts, Dr. Carter, will be exactly to uncover that kind of record. We will seek every conceivable bit of data that will give us information, accurate information, on who was there, how they participated, and what exposure they received.

Mr. CARTER. I want to know again, what has become of these rosters? Five copies of all rosters were required to be turned into DOD security a minimum of 6 hours prior to departure in convoy.

I would just like to know what happened to them all.

Admiral MONROE. The rosters that I believe you are speaking of, sir, are the Army rosters from Camp Desert Rock; and you were describing the procedures by which the convoys from Camp Desert Rock went through the security——

Mr. CARTER. I am not sure it is just confined to the Army. Although I know that the Navy had very little participation out there.

Admiral MONROE. No, sir. The Army had the responsibility for the——

Mr. CARTER. But there were 2,100 marines, I believe, who had radiation exposure.

Admiral MONROE. The Army had the responsibility for the operation of Camp Desert Rock. Thus the units, of whatever service, at Camp Desert Rock, were under the administrative control of the Army. Those rosters you speak of would have been filed in the Army records system, and these are exactly——

Mr. CARTER. That colonel on the staff back there should know something about it.

Admiral MONROE. Yes, sir.

Mr. CARTER. He should be able to retrieve them without all this difficulty.

Admiral MONROE. Yes, sir. He is attempting to do just that.

Mr. CARTER. Thank you, Mr. Chairman.

Mr. ROGERS. These have not been found yet, or have they been looked for?

Admiral MONROE. They have been looked for by the Army in their research effort, but they have not yet been found, rosters of this kind. I assure you, Dr. Carter, this DOD effort, which is now a week or two underway, is determined——

Mr. CARTER. Has the Army been so totally disorganized and so poorly coordinated in the past several years that you cannot even give the names of the men who were at these places?

Admiral MONROE. No, sir. It is simply that the records have not——

Mr. CARTER. Well, I will tell you, in this day of computers and data retrieval systems, and so on, I would expect that you will do better in the future. It seems to me that you should.

Admiral MONROE. Dr. Carter, if I might comment on that, there are many records of the past of 20 or 30 years which would have been computerized, had that process been in use at the time. The intensity of interest and total commitment of the Department of Defense to this issue now has led us to this research project, to uncover these records and do just as you are proposing; but it was not irresponsibility or neglect or disorganization. The records were filed in the manner in which they were kept; and we must now retrieve them for a different purpose, and that is what we are engaged upon.

Mr. CARTER. Admiral, as I said a few days ago, it would be easier to get a roster of a unit which fought at Shiloh than it is to get a roster of a unit at Desert Rock, and I defy you to prove otherwise.

Mr. ROGERS. There is a vote calling members to the floor. We will recess for 10 minutes, and then we will be back.

[Brief recess.]

Mr. ROGERS. The subcommittee will be in order.

STATEMENT OF LT. COL. GEORGE S. KUSH

Colonel KUSH. I am Lt. Col. George S. Kush of the Air Force. I am responsible for identifying all the Air Force participation in the atmospheric nuclear weapons testing program.

Mr. ROGERS. All right, Colonel.

Colonel KUSH. I have assembled a team of eight officers on the Air Staff who represent all of the major Air Staff Directorates which will be involved in the project to identify all of the Air Force participants. I will also be able to use personnel from the USAF Occupational and Environmental Health Laboratory and the USAF School of Aerospace Medicine, both located at Brooks Air Force Base, Tex., to aid in this identification program.

Mr. ROGERS. Are these eight people full time?

Colonel KUSH. No, sir, they are part time. The rationale for this, sir, is that we have the resources of the two laboratories that we can use full time on this project. Another is that the Air Force has extensive records on its participation in this program.

Mr. ROGERS. How many people from the Air Force are involved, Colonel, in this program?

Colonel KUSH. All told, sir, there will be about 30 to 40 people.

Mr. ROGERS. Excuse me?

Colonel KUSH. Thirty to forty people will be involved to complete the study.

Mr. ROGERS. No; I am saying how many Air Force personnel were involved?

Colonel KUSH. Approximately 20,000 to 30,000 people were involved in the tests. Approximately one-half to three-quarters of these individuals were never exposed to radiation. As an example, there were air crew who were flying personnel between Hawaii and Washington. They are listed as being part of the test.

We feel confident in this estimate because of our film badge data repository at Wright-Patterson AFB, Ohio, which contains data back to 1946, before the Air Force was established as a separate service. Our film badge repository was established in 1955.

In 1964, we extracted all of the film badge data on the test program from the old Nevada Operations Office, located at the test site, which is now part of DOE. We punched that information onto data cards, and incorporated it into our film badge repository at Wright-Patterson AFB, Ohio.

Mr. ROGERS. Well, the committee commends the Air Force.

Mr. CARTER. Since what date, Colonel?

Colonel KUSH. Sir, that repository goes back to Operations Crossroads in 1946. As an example, we were able to obtain Peter Radford's record, who I believe previously testified before the subcommittee. His film badge record was zero. This is an example of this record system's capabilities.

We are able to obtain individual's names by operation from that repository.

Mr. CARTER. The film badge record?

Colonel KUSH. Yes, sir.

Now, in addition to that, Dr. Carter, we also have records of all of the operational tests. In fact, I am traveling tonight to Brooks Air Force Base to review some of those operational test records and correlate the data from these files with the film badge records that we have at Wright-Patterson AFB, Ohio.

Mr. CARTER. Mr. Chairman, I certainly want to congratulate the Colonel and the Air Force on their diligence and foresight. I really believe that if you had been in charge of the operation, we might have been able to retrieve a little bit more of the information which would be helpful today.

Thank you, Mr. Chairman.

Mr. ROGERS. Have you also been able to track down the Air National Guard people involved?

Colonel KUSH. No, sir, not yet. We are going to look at the operational test report. They are not in the film badge repository. Since they flew in, I believe, from Tennessee and were not part of the operation as we know it, they may have not been film badged.

The operational test reports list a large number of Air Force personnel and we are double checking on their participation with people who are still in the service and were involved in the experiments and other exercises that went on during the nuclear events.

Mr. ROGERS. Well, you said you had eight people involved. How much of their time will be devoted?

Colonel KUSH. Two people full time, sir, the rest on a part-time basis.

Mr. ROGERS. Will you let us have their names and the times for the record?

Colonel KUSH. Yes, sir.

[The following information was received for the record:]

Air Force Atmospheric Nuclear Weapons Testing Team

Rank/name and organization	*Percent of time*
Lt. Col. George S. Kush, AF/SGPR	100
Capt. Jerry Wiseman, AF/XOORA	5
Lt. Col. David C. Beatty, AF/RDPS	5
Maj. David G. Wood, AF/SGPR	100
Mr. Jack Neufeld, AF/CHO	40
Capt. Gary D. Hawksworth, SAFOIPA	10
Maj. Walter D. Philips, AF/JACC	10
Capt. Brian Kessler, SAFLL	5
Maj. Richard Fowler, AF/DPXX	20

Mr. ROGERS. All right, sir. Anything else?

Colonel KUSH. Our participation was somewhat uniform through all of the events, so we are not concentrating on any one particular event. We do have to look at each event because we had Air Force participation at all tests.

Mr. CARTER. Do you think that Air Force personnel were at greater or lesser risk than other personnel?

Colonel KUSH. Sir, if by risk do you mean exposure?

Mr. CARTER. Yes.

Colonel KUSH. I would say that some Air Force personnel had more radiation exposure than the other services, because our personnel would participate in several events. I know several people personally who participated in approximately 60 to 70 events.

Mr. CARTER. Sixty or seventy?

Colonel KUSH. Yes, sir, of the 300-plus events that occurred.

Mr. CARTER. Do you know the total rems exposure or the average exposure of any of those men?

Colonel KUSH. No, sir. I would not want to—I could certainly obtain some of these records, and we could insert this information for the record, if you so desire. This information is available in our film badge repository.

Mr. ROGERS. Yes, if you would submit that for the record.

[The following information was received for the record:]

MONTHLY FILM BADGE EXPOSURES (ALL SERVICES)-OPERATION CROSSROADS (1946)

Exposure ranges	Gamma exposure		Beta exposure[1]	
	Number	Percent of total	Number	Percent of total
0-9mR	7,164	63.3	10,434	92.1
10-99mR	2,686	23.7	56	0.5
100-999mR	1,455	12.8	474	4.2
1,000-9,999mR	19	0.2	359	3.2
Total	11,324		11,324	

[1] Beta exposure ranges are in mRads.

NOTE.—For Operation Crossroads we only have the names and the organizations of the individuals, but not their service numbers. A review of the operational test reports will be required to get more complete data.

Mr. CARTER. Could you tell me about the 4,926th test squadron out of Indian Springs Air Force Base which did cloud sampling?

Colonel KUSH. Yes, sir. This is one of the groups that we are particularly concerned about because many of the crew there went out and did cloud sampling in several events. They just did not fly in one event and then leave. Sometimes they participated in the entire series.

We also are looking into the records of ground personnel who were film badged, and participated in the decontamination of aircraft when there was any indication of the aircraft being contaminated.

Mr. CARTER. Some of these men accumulated a total of 35 roentgens, is that not true?

Colonel KUSH. Sir, we will have to look at the records. Again, we plan to review the individual's total exposure when we identify everybody's participation in the events.

Mr. CARTER. I believe I am reading from a copy of the record, or something taken from the record.

Colonel KUSH. Sir, I am not aware of what you are reading from.

Mr. CARTER. I am reading an article that was taken from the record, when I say that some of your people received as much as a total of 35 roentgens.

You did not get the names of the men from the Tennessee National Guard group, is that correct?

Colonel KUSH. No, sir, I do not have those names now.

Mr. CARTER. Do you know what percentage of them developed leukemia?

Colonel KUSH. No, sir, I do not.

Mr. CARTER. Do you know that some of them did develop leukemia?

Colonel KUSH. Sir, I believe one allegedly developed leukemia.

Mr. CARTER. Not allegdly. One has leukemia.

And how many personnel involved in these tests have developed leukemia so far?

Colonel KUSH. Sir, we have never done a complete medical followup of any of the participants in the weapons tests.

Mr. CARTER. All right. Thank you very kindly, Colonel.

Mr. ROGERS. All right. Could we hear from the Marine Corps now, Admiral?

Admiral MONROE. Sir, Maj. Rafael Negron.

Mr. ROGERS. Major Negron?

STATEMENT OF MAJ. RAFAEL NEGRON

Major NEGRON. Mr. Chairman, members of the subcommittee, the Marine Corps views the task of identifying Marine test participants and their exposure levels as a staff agency—as a staff effort, involving the expertise of several staff agencies in our headquarters. Accordingly, we have convened a committee, an ad hoc working committee, under the cognizance of a project director.

I am Major Negron, the project officer at Headquarters Marine Corps.

The committee consists of a myriad of specialists to include representatives from data systems, public affairs, intelligence, medical, legal, and our historical division. The working committee has been tasked with two specific missions: First and foremost is the immediate identification of the Marine test participants to include the establishment of their exposure levels and eventually the creation of a system which will enable us to locate those participants if needed.

The identification stage involves the identification of units, troops, and observers. The identification of those units involved is readily available from documents held in our own archives. These documents include, but are not limited to, operational and administration orders, afteraction reports and public affairs releases.

Once units are identified, unit diaries are also available in our archives. These unit diaries do identify individual Marine troop participants to include those Navy medical personnel and Navy chaplains attached to participating units. At this time, all Marine Corps units involved in three of the major Marine Corps troop tests have been identified. Those series include Upshot Knothole in 1953, the Teapot Series of 1955 and the Plumbbob series of 1957.

Respective troop lists are available at this time, but they will require further minor refinement to more positively indicate individual marine participants and accurate exposure data.

Many of the test participants are being identified via the toll-free number established by the Defense Nuclear Agency. As this information becomes available, it is being computerized for future reference.

After the troop identification is complete, the degree of difficulty increases significantly. There were many marine observers involved in several of the tests conducted by both the Army and the Navy. In the Desert Rock seven and eight series alone, there were 100 marine observers.

Although some information is available in our archives, it is far from complete and we fully anticipate that we will need to coordinate with other governmental agencies to supplement our own information.

At this time, the Department of the Army and the Department of the Navy and the Defense Nuclear Agency have been most cooperative in this endeavor, and have already provided much important information, and it is anticipated that other governmental agencies, such as the Department of Defense Nuclear Information and Analysis Center and the Department of Energy, will be eventually contacted for assistance.

If it is determined that any test participant should be notified, the working committee will be prepared to obtain the current address of test participants. Current addresses of those marines on active duty, retired or in the Reserves, are available through our personnel files at the finance center in Kansas City for the Defense Manpower Data Center.

If a test participant has been separated from the Marine Corps, a last known address will be taken from the records in St. Louis. If a current address in required, assistance will be requested from agencies such as the Internal Revenue Service.

Gentlemen, in conclusion, I would like to emphasize that the Marine Corps is prepared to cooperate fully with all concerned Federal agencies to expedite the identification of test participants and their exposure levels.

Mr. Rogers. Thank you, Major Negron.

How many of the total number of marines is it estimated were involved?

Major NEGRON. Sir, at this time, we estimate that there were between 12,000 and 15,000 marines involved, this includes the Pacific as well as the Desert Rock series.

Mr. ROGERS. When has your committee met?

Major NEGRON. Sir, the committee met last week.

Mr. ROGERS. How many meetings have you had?

Major NEGRON. We have had one, sir.

Mr. ROGERS. How many people are involved?

Major NEGRON. Sir, we have two project officers working on this full time. In addition, we have three people in the historical branch, our historical branch in the archives working on it full time. And, of course, we have 10 people from various agencies within our headquarters working on it part time.

Mr. ROGERS. Would you let us have the names of your committee members and those who work and the number of hours estimated that are involved?

Major NEGRON. Certainly, sir.

[The following information was received for the record:]

MARINE CORPS HEADQUARTERS COMMITTEE

There are presently two officers at Headquarters, Marine Corps working on this subject on a full time basis. They are: Maj. R. Negron, Jr., and 2d Lt. K. Gardiner.

There are also three people from our archives working on the project full time. They are: Dr. Martin Gordon, Miss Gabrielle Newfeld, and Mr. Danny Crawford.

The working committee consist of specialists from several agencies from within our headquarters. These people are working on the project on a partial basis. They are: Public Affairs: Capt. P. C. Coulter; Judge Advocate: Capt. D. P. Cosgrove; Operations: Maj. B. C. Henry; Intelligence: Capt. B. L. Lee; Veterans Affairs: Maj. J. F. X. Connolly; Records: Mr. C. Rose; Data Systems: Capt. D. Jenkins; and Medical: Cmdr. G. Harris.

Mr. ROGERS. Do you have any questions?

Mr. CARTER. How many marines were at the Hood explosion?

Major NEGRON. Sir, we had 1,706 marines; although the press releases indicated 2,100, the afteraction report indicates that there were 1,706.

Mr. CARTER. You are pretty sure of that?

Major NEGRON. Yes, sir, I am.

Mr. CARTER. But you do not have the names?

Major NEGRON. I have 1,625 of the names, sir.

Mr. CARTER. You have about 1,600 of the names now?

Major NEGRON. Yes, sir, I do.

Mr. CARTER. That's very good. That is almost as good as the Air Force. I want to compliment you, too.

Major NEGRON. Thank you, sir.

Mr. ROGERS. Thank you, Major.

Major NEGRON. Yes, sir.

Mr. ROGERS. I believe that is all of the services, is it not?

Admiral MONROE. Yes, sir.

Mr. ROGERS. Now let me ask this. When did the Department really first learn of a possible link between troop participation in nuclear tests and cancer?

Admiral MONROE. The first direct indication that I am aware of, sir, was in February 1 year ago, when Dr. Caldwell of the Center for Disease Control contacted the Armed Forces Radiobiology Research Institute. Since then, there has been a steady progression of continuing and growing DOD involvement up to the present. I think there * * *

Mr. ROGERS. Let me just read you a letter——

Admiral MONROE. I was going to say, I think there were probably isolated instances in past years of individuals who contracted leukemia or other cancers, and who applied to the Veterans' Administration. The claimant might have contacted either the services or Defense, or the VA might have, in an attempt to establish a service connection. Data on each specific case was provided, as available. To my knowledge, no study has ever been undertaken of the subject this committee is addressing—the risks from low-level ionizing radiation—within Defense.

Mr. ROGERS. Let me read a letter to you, to Hon. Melvin R. Laird, Secretary, Department of Defense, dated January 8, 1970. It is from Hon. Olin E. Teague, chairman of the Committee on Veterans' Affairs, and I quote:

> DEAR MR. SECRETARY: The National Broadcasting Company program "First Tuesday," broadcast on January 6th, made reference to the case of a veteran by the name of Patrick Stoud, whose disability and later death was determined to be service-connected because of the exposure which he suffered as a member of the Army during the first atomic bomb blast.
>
> This is a case in which I was personally interested and was instrumental in having reviewed by an independent medical expert, which later resulted in his death being declared service connected, based on the expert testimony of an independent doctor after the initial claim had been denied by the Veterans Administration.
>
> The broadcast also related that, in subsequent tests, 5,000 Army troops were exposed to a bomb blast and a smaller number of Marines, and that no medical follow-up had ever been made of these personnel.
>
> It seems to me that a medical follow-up is in the public interest. It would therefore be appreciated if you would cause to have ascertained and identified the individuals, both in the Army and the Marine Corps who were exposed to those tests so that this Committee could ask the Veterans Administration to determine if claims had been filed and of what nature, by the individual involved, and be advised as to the disposition of such claims by the agency.
>
> I realize, of course, that this will take some time to accomplish, but I do think action along these lines should be taken as soon as possible. Your cooperation will be appreciated.

In response to that, there is a letter from Carl Walske, Assistant to the Secretary of Defense, Atomic Energy. This is dated May of 1970, May 15, to the Honorable Olin Teague.

> DEAR MR. CHAIRMAN: This is in further response to your letter of January 8, 1970, concerning Army and Marine Corps personnel who, as noted on the "First Tuesday" television program were participants in atomic bomb tests in Nevada. We have now an opportunity to examine the records of these troop exercises and to discuss them with both the Veterans Administration and the Atomic Energy Commission. During the period 1950 to 1957, more than 50,000 troops participated in one way or another in the series exercises known as Desert Rock. The actions of these men were carefully controlled in order to minimize their exposure to nuclear radiation and to document the circumstances, should any significant exposure occur.
>
> Film badge dosimetry was used primarily as a means of confirming, at the time, that the radiation safety measures were effective. Dosimetry records, therefore, were not centrally maintained once they had served this purpose. Thus, it has not been possible to retrieve all the exposure data or to determine with assurance that the records that are available are complete.
>
> In this connection, it is noted that in several of the exercises, troop units rather than individuals were monitored, again, making the identification of individuals after these many years a difficult, if not impossible task.
>
> However—

And I think I would direct your attention particularly to this, Admiral—

> However, during the past several months, with the cooperation of the Atomic Energy Commission, we have retrieved from the archives and from record repositories all of the available radiation exposure data.

This was done in May of 1970.

> We estimate that we have on hand exposure records covering at least 80 percent of the participating troops and we have found no reason to expect that the data on this 80 percent sample are not truly representative of the whole.
>
> Based upon detailed examination of these data, as well as historical records of the Desert Rock exercise and the personal recollections of a number of responsible officials, I am confident that no Desert Rock participant received a medically significant exposure. At the suggestion of your staff, however, we have made the necessary arrangements to preserve all of the subject records. They are now a permanent part of the Atomic Energy Commission's data bank to which the Veteran's Administration has full access.
>
> Our staff contacts with the appropriate VA officials indicate that they find these arrangements entirely satisfactory and in accord with their established procedures. If I may be of further assistance—

It would appear to me that the records have already been gathered and are a part of a data bank currently in existence. Would I be in error in assuming that, Admiral?

Admiral MONROE. I think the study, Mr. Chairman, that we are undertaking is a great deal more detailed, and in much deeper scope, than that referred to there—which, incidentally, I was not aware of, nor was anyone that we have worked with in this effort.

I believe the records they are referring to are the exposure records kept by REECO, Reynolds Electrical & Engineering Co., a contractor of the now-Department of Energy at their Nevada Operations Office in Las Vegas. These records, which I think have been described by Dr. Kerr of the Department of Energy, do contain the exposure data, of several hundreds of thousands of individuals. I believe I am correct in that number. These are both military and civilian. The military are of all services; the civilians are some Department of Defense, but mostly Department of Energy.

This data, however—while computerized—is not easily correlatable with individual and unit participation. We are working intensively with the Department of Energy, with their full cooperation, to get this exposure information; and, of course, these records will be compared with the exposure data we get from individual medical records.

But we have not yet been able, for example, even in a year's work on Smoky, to go into these files and get the kind of data that we would like to be able to provide rapidly to Dr. Caldwell of CDC.

The REECO data will be used, but we will develop, in the course of our work, much more complete information, sir.

Mr. ROGERS. Well, I understood from the Army that they were having difficulty locating records. However, it would appear that this has already been done for about 80 percent of the participating troops and the troop units.

Admiral MONROE. May I ask Colonel Hugo of the Army, who has some familiarity worked with these REECO files, to describe his perception of their capabilities and limitations in the work he is doing.

Colonel Hugo. I would ask also Major Skerker to amplify any comments that I might make to you, Mr. Chairman.

Mr. Rogers. Certainly.

Colonel Hugo. It is my understanding, sir, that the REEC records, referred to by Admiral Monroe, are primarily associated with the tests that took place in 1951. The Army assumed responsibility for more of the radiation monitoring beginning in 1953 and continuing through the end.

Now, it is my understanding, sir, that we have the records for 1951, the radiation exposure records for 1951 as well as for 1957. The latter, of course, are the film badges that were developed and processed by the Lexington Army Signal Depot.

In the intervening years, sir, it is my understanding that we do not have those records at this moment, and I would ask——

Mr. Rogers. This is the period from 1951 through 1957?

Colonel Hugo. Yes, sir.

Mr. Carter. Mr. Chairman?

Mr. Rogers. Yes?

Mr. Carter. I would like to ask, sir, did you say that you have the records of those men at the 1957 blasts?

Colonel Hugo. That is my understanding, sir. Yes, sir.

Mr. Carter. How many of those have been turned over to Dr. Caldwell down at CDC?

Colonel Hugo. All of the records, sir, from shot Smoky were turned over to Dr. Caldwell.

Mr. Carter. All of the records and all of the names?

Colonel Hugo. Yes, sir, that is my understanding. Is that correct, Major Skerker?

Major Skerker. Yes, sir.

Dr. Carter, as I indicated last time I was here, we have all of the 1957 records from Camp Desert Rock. From that set, we have extracted a list of Smoky participants and provided that to Dr. Caldwell. We have also provided to Dr. Caldwell at his request extracts of certain projects, 50.8.

Mr. Chairman, what you read in the letter there about the 80 percent complete is simply wrong. It has to be wrong if, for nothing else, than the fact that, in the intervening years, we know that everyone was not film badged, so there is no way that one is going to find 80 percent of the participants in a film repository.

Mr. Rogers. He states that here.

Major Skerker. I know he did.

Mr. Rogers. He said, "In this connection, it is noted that in several of the exercises, troop units, rather than individuals were monitored again making the identification of individuals difficult. However, during the past several months with the cooperation of the Atomic Energy Commission, we have retrieved from the archives and from record repositories all of the available radiation exposure data and we estimate we have on hand exposure records covering at least 80 percent of the participating troops."

Admiral Monroe. Mr. Chairman, if I might amplify.

Mr. Rogers. Certainly.

Admiral Monroe. These are computerized files giving simply names, a modicum of identifying data, and a film badge reading. For a scientific research organization such as CDC or NRC to arrive at valid conclusions they will need much more than that. They will need to know where the units were, how close the individuals were to the detonation, how their movements were timed after the detonation, the age of the individuals, their exposures to radiation at other times in their lifetime before and after the shot, and so on.

Mr. ROGERS. Did you think that was important in 1970 when you got all of these records together?

Admiral MONROE. I think that letter was not answered in as broad a context as we are planning to undertake this current study.

Mr. ROGERS. Well, it was asked to do a medical followup. I think that is what we are planning to do; is it not?

Admiral MONROE. Yes, sir. We are planning to provide——

Mr. ROGERS. Well, what I am saying is, and I do not know that you can do much about going back where someone has done something else. But all I can say is that they claim 80 percent of the records are already available.

Now, of course, we might have to do some more search. CDC—that was even resisted, to give CDC the names. They claimed they could not get them, that CDC had the names. Now we found in 1970 that all of these names are available.

So our concern is that there is a resistance to——

Admiral MONROE. None at present. I cannot speak in any way for the past; but certainly, Mr. Chairman, there is absolutely none at present, and there has not been any in our dealings with Dr. Caldwell of the CDC over the past year.

Mr. ROGERS. Well, he went to the Army and the VA first and the Department of Defense said that the only way they could help him was if he could furnish the names. Then they could search the records to see if these individuals were present at Smoky. That was the testimony.

Admiral MONROE. And, sir, by the time of our December 1, meeting with Dr. Caldwell, the decision of that interagency group meeting was to march off smartly with this very, very extensive, time-consuming, and expensive study to get those names for him. They are just simply not available by any easy means or recourse.

Mr. ROGERS. Well, I would think, perhaps, a good starting point would be these records that the Department of Defense said they assembled in 1970. Does the Army disagree with that?

Admiral MONROE. No, sir, we do not. Those have been used, have been employed——

Mr. ROGERS. They said they did not have them. They were afraid they did not have the records. They did not even know where the unit records from Desert Rock were. Well, evidently they have gone through all of them and they have assembled data on all of the units, which participated, from 1951 to 1957.

Admiral MONROE. Sir, I believe the effort which was done in years past, which resulted in these individual Department of Defense exposure data being incorporated in the REECO files, were done for selected groups of selected people; for example, Desert Rock participants in 1957.

Mr. ROGERS. The letter says, "During the period 1951 through 1957, more than 50,000 troops participated."

Admiral MONROE. Yes, sir, and our——

Mr. ROGERS. Well, that says to me, from the rest of the letter that they have assembled 80 percent of the names of the 50,000 or the troops there.

Admiral MONROE. Mr. Chairman, I simply cannot put myself in the position of the man who signed the letter, Dr. Walske, and tell you just exactly what he was referring to, but I can describe the current state of these files, and——

Mr. ROGERS. Has anyone looked at these files?

Admiral MONROE. Yes, sir, a number of——

Mr. ROGERS. These particular files? The Army has not. Have you, Admiral?

Admiral MONROE. No, sir.

Mr. ROGERS. Has Mr. Haas?

Admiral MONROE. The ad hoc committee that was formed——

Mr. ROGERS. Excuse me. Let me find out if anyone has looked at them. Has anybody?

Major SKERKER. Yes, sir those are the REECO files.

Mr. ROGERS. Have you looked at them yourself?

Major SKERKER. I have the 1968 version of the REECO files.

Mr. ROGERS. You have what?

Major SKERKER. A 1968 version of the REECO files.

Mr. ROGERS. Have you looked at these from 1951——

Major SKERKER. The one from——

Mr. ROGERS [continuing]. From 1951 to 1957?

Major SKERKER. The one from 1957 incorporates the Lexington film badge records.

Mr. ROGERS. You are talking about REECO files? Are those from the Reynolds Co.?

Major SKERKER. Sir?

Mr. ROGERS.You are talking about the Reynolds Co. files?

Major SKERKER. Yes, sir. The Reynolds Electrical & Engineering Co. files, at the AEC. The effort—it was in that period of time, between the late 1960's and early 1970's when an effort was made to secure dosimetry records from wherever they resided, to get them complied on the AEC computers which are contracted by the Reynolds Electrical & Engineering Co.

Mr. ROGERS. Have you seen those files?

Major SKERKER. I have a printout, sir, of a 1968 version. I have not seen the later version of that.

Mr. ROGERS. Have you seen the files that covered the years 1951 through 1957?

Major SKERKER. I have been told by the Department of Energy that the 1957 Lexington film badge records were incorporated into the REECO files and that is an update of the 1968 version that I have. But I have not physically seen the updated version, sir.

Mr. ROGERS. Now, what does it give you, just the name of the man or the unit?

Major SKERKER. No; sir. It gives you the name of the man, in some cases the rank, an identifying number. In some years, that is the social security number. In other cases, it appears to be a badge number or some mixture of digits, we cannot really figure out what it means.

Then it gives you—on the printout, there is a column for—I think it is the last quarter's dose, total accumulated dose—and then a period of time that the printout record is for. There is a total exposure and the period, the duration, over which that total exposure was accumulated.

The printout also contains duplication. Now, whether or not another list exists that is devoid of that duplication, I do not know, sir.

Mr. ROGERS. How long will it take to get the 1951 to 1957 files in shape?

Major SKERKER. On June 5, the Army made a formal request to the AEC to obtain the updated version of the REECO files and we were subsequently told, and I do not recall the date that the letter came back to us, that we could not have access to those files because of the Privacy Act, sir.

Mr. ROGERS. Have you had any contact with them since then?

Admiral MONROE. Yes, sir, a continuing one. We will resolve—and to some degree we have resolved—the Privacy Act problems, which, of course, affect us at every transition point, then we go from Defense to Energy, when we go from Defense to VA, when we go to the IRS, and so on. But we fully expect to resolve all Privacy Act difficulties.

I might add one amplifying comment. Dr. Walske, referred to some 50,000 Desert Rock personnel exposed, stating that about 80 percent were in the files. That would make some 40,000 film badge readings, and he stated, as I recall from the letter, that this was all that were available. This may be the case; however, we think we are talking about 200,000 to 300,000 people in the Department of Defense——

Mr. ROGERS. From 1951 to 1957?

Admiral MONROE. No, sir. Over the entire, broader area that we are investigating.

Mr. ROGERS. I understand that. He was only asked about 1951 to 1957.

Admiral MONROE. Yes, sir. I think those records focus on participation in those years. In summary, I would say we are aware of the REECO files, we are using them, we have contact virtually daily with the people managing the REECO files. But they are by no means a magic source of information to make a very difficult task simple.

Mr. ROGERS. What is the difficulty now with the ACE or its successor giving you all of their records?

Admiral MONROE. I do not believe we have any, sir, beyond the Privacy Act.

Mr. ROGERS. I thought that the Major said that there were. Privacy, still?

Admiral MONROE. Yes; I think the Department of Energy may have testified to this. I did not read all of their testimony. Within the last week they have filed a notice in the Federal Register, and I should really let them describe it exactly, which gives notice to the fact that they intend to open those energy files to the Department of Defense, and allowing a 30-day period in which anyone could object, if they want to, and——

Mr. ROGERS. When will that 30-day period be up? Is anyone from DOE here?

Could you identify yourself for the reporter?

Dr. KERR. I am Donald Kerr. I am Acting Assistant Secretary for Defense Programs at DOE. We published in the Federal Register today the required notice; and 30 days from today those records will be available to the DOD, HEW, and the National Academy for whatever studies they would like to conduct.

Mr. ROGERS. How many records have been found?

Dr. KERR. As I testified to the committee before, approximately 450,000 records exist in our files. The exact number is contained in an attachment to the letter that I sent you on the 8th of February.

Mr. ROGERS. So we do have the record of some 400,000?

Dr. KERR. That is correct. That is the total number of records contained in the REECO files. It consists of AEC, ERDA, DOE, and contractor personnel, military personnel on assignment, and certain military personnel that participated in the exercises.

Mr. ROGERS. Are these just records from exercises conducted in the United States, or in the Pacific as well?

Dr. KERR. No, sir. As I testified earlier, it consists of both.

Mr. ROGERS. So you have both.

Dr. KERR. That is correct.

Mr. ROGERS. Is there any estimate of how many of these are military alone?

Dr. KERR. Off the top of my head, I cannot answer that. Perhaps when I come to the table I can answer it from my material. If I can, I will. If not, I will try to provide it, sir.

Mr. ROGERS. Thank you.

So evidently, we have records, but this is the first move to get, is this publication.

Admiral MONROE. We have been able to get statistical data from the records but not names and exposures. That is protected by the Privacy Act.

Mr. ROGERS. It would appear to me, Admiral, that we still need to give a little more urgency to this. If there are roadblocks, the committee wants to know it, and if there are not sufficient personnel assigned, the committee wants to know that too. We will have another hearing shortly to follow up.

We plan to follow this matter closely to see what is done. Where there is no action, we plan to spotlight it and then to have action taken.

Admiral MONROE. Yes, sir. I know that the Secretary of Defense shares your view on the importance of the effort. On the 28th of January he initiated this major program we have described here. That was just 2 weeks ago. We, at this point, have, by my count, 105 people working full time in my agency and in the four services on this task. We surely will advise you, Mr. Chairman, of any roadblocks that we cannot sweep aside ourselves. There are many. The fire at GSA; the incompatibility of records; the lack of social security numbers; the Privacy Act; but we expect to overcome all of these, and we will come to you if we cannot.

Mr. ROGERS. Do you think an act of Congress is needed authorizing and directing the conduct of this expanded study specifically and providing adequate funding?

Admiral MONROE. May I provide an answer to that for the record, sir? That is a broader question than I would feel comfortable answering here.

Mr. ROGERS. Yes, you may. And we will also have some additional questions for the record which you could answer.

[Testimony resumes on p. 1128.]

[The following information was received for the record:]

ADDITIONAL FUNDING FOR EXTENSIVE STUDY BY DOD

As regards the Act of Congress, it is not required. The Department of Defense is totally committed to carrying out this extensive study. As regards the funding, we are attempting to handle the present effort within existing fiscal year 1978 appropriations. We are still working to scope the total effort, thus it would be premature to make a positive statement now about future needs for specific program funding. We are, of course, making every effort to do a thorough job, and to do it in the most efficient and economical manner. While we will make every attempt to provide the necessary financial resources within existing appropriations, we will not hesitate to request additional funds if this becomes essential to assure the timely accomplishment of this program.

DEPARTMENT OF DEFENSE

REPLIES TO QUESTIONS

GIVEN TO DEFENSE REPRESENTATIVES

A. ADDITIONAL QUESTIONS FOR DEFENSE DEPARTMENT WITNESSES

QUESTION:

Under what authority did the military services decide to expose military personnel to nuclear tests and to engage troops in military maneuvers associated with those tests? Who made that decision? When was it first made?

ANSWER:

Military maneuvers and military personnel participation in atmospheric tests were authorized for Operation TUMBLER SNAPPER, 1 April 1952 through 5 June 1952, and for subsequent operations, in a JCS memorandum for the Chief of the Armed Forces Special Weapons Project (AFSWP) dated 18 January 1952.

For years prior to 1952, the specific high-level authorizing documents for military troop participation in nuclear weapon tests have not yet been identified. The search is continuing as part of DoD's major research effort.

QUESTION:

Concerning the nuclear test program in the Pacific:

- Did the Defense Department direct and control the Pacific test program?

ANSWER:

All Pacific nuclear test programs were conducted by a Joint Task Force (JTF) organization reporting to the Department of Defense or its predecessor. In 1946, the Joint Chiefs of Staff established JTF-1 from the Military Departments, the Manhattan Engineer District, and other government agencies. JTF-1 directed and controlled the CROSSROADS series of 1946. For all subsequent Pacific tests, the Atomic Energy Commission replaced the Manhattan Engineer District in the JTF structure. The Joint Task Force commanders, all military officers, exercised direction and control of the tests for the Joint Chiefs of Staff, and reported to them. The JTF commanders were assisted and advised by a Scientific Director, a scientist appointed from within the Atomic Energy Commission and its weapons laboratories. Formal liaison and coordination between the Department of Defense and the Atomic Energy Commission was via the Military Liaison Committee. Thus, the Department of Defense did direct and control the Pacific test program with advice and coordination at command level from the Atomic Energy Commission.

QUESTIONS:

- What were the radiation exposure standards for the Pacific test program from 1946 on? By whom and on what basis were these standards set? Were they enforced? How successfully?
- How many personnel - civilian and military - participated in the Pacific testing program? Please provide a breakdown by service.
- Were film badges provided to all Pacific test personnel? If so, do those records exist? If not, why not?
- What is the record of human radiation exposures among participants in the Pacific testing program?
- Were any military maneuvers conducted in conjunction with any Pacific test? If so, please describe.

- Were any personnel - civilian or military - killed or seriously injured as a result of the Pacific testing program? Was any military equipment inadvertently destroyed or damaged beyond repair as a result of the Pacific tests?
- What became of ships contaminated during the Pacific testing program? Were they decontaminated, destroyed, junked, or decommissioned? If so, where was this done?
- If ships were decontaminated, what precautions were taken to assure the safety of decontamination workers? Have there been any reports of increased cancer among ship decontamination workers?

ANSWER:

These questions cannot be answered at this time. As discussed in testimony on February 14, the Department of Defense has embarked on a major research effort to develop and organize all available information pertinent to personnel exposures in nuclear weapons testing - including the type of data necessary to answer these questions. Responses will be provided as soon as they are available.

QUESTION:

Did the previous Department of Defense testimony take into account all Navy and Air Force personnel who may have observed, or participated in maneuvers associated with, nuclear tests in Nevada? Are there records which indicate attendance at the tests and resulting radiation exposures for such Navy and Air Force personnel?

ANSWER:

The estimate of 58,537 military personnel applied only to Desert Rock participation. It included personnel from all Services assigned to Desert Rock Headquarters, but it did not include personnel associated with other nuclear tests in Nevada. That information, together with exposure records for all military personnel, will not be available until each Service completes a review of its records and identifies its own personnel. The current DoD review will cover all DoD participants--all services, all organizations--to the extent data is available.

QUESTION:

Is it true that someone in the Defense Department is running a check of the roster of participants at 1951 Camp Desert Rock against the Armed Forces tumor Registry?

- If so, who authorized this study? At what cost? For what purpose?
- Has a larger study design or protocol been developed of which this review is a part? Shouldn't such a study await the expanded epidemiological study of the nuclear test program?

ANSWER:

The effort in question is not a "study," but rather part of the data-collection effort.

The process of checking names of participants in atmospheric nuclear weapons tests against the files of the Armed Forces Pathology Institute Tumor Registry (AFPI) was first done in the summer of 1977 for Smoky participants. As soon as the Smoky troop list was developed by the Army, that service took the initiative of cross-checking it with the AFPI. The cross-check produced 16 possible name matches. At that same time, Dr. Caldwell of CDC had produced a list of 10 possible Smoky/leukemia match-ups. By December 1977, it was determined that of these potential leukemia cases, six were positively confirmed as being present at the test site during the period when the Smoky event occurred. Of these six, four were from the original CDC list and two were first identified by the Army's AFPI check.

Once the Smoky cross-check was completed, the comparison moved on to the 1951 Desert Rock participants. This group was chosen because troop identification for 1951 was the most complete (obtainable from the Army's 1968 printout of REECO files--which contained troop names because the AEC badged troops in 1951). This effort was initiated by the Army Surgeon General in the summer of 1977, and is still ongoing. It is being done as an in-house project by the Epidemiology Consultant Agency (EPICON) of the Army's Medical R&D Command at Walter Reed. As such, costs are not separately identified.

This review is not a part of any separate larger study. Its purpose is to produce data, not reach conclusions. As such, it is a reasonable sub-effort of the major DoD research program, and has already proved its worth in identifying the Smoky cases.

QUESTION:

On pages 16 and 17 of his January 25 testimony Major Skerker pointed to deficiencies in radiation measuring equipment: "No available rate meter meets military specifications and measures beta radiation satisfactorily. Casualties could easily result from beta burns received in a contaiminated area indicated safe by gamma instruments of the AN/PDR-39 or IM-108 type."

Doesn't fallout from a nuclear test contain high levels of beta-emitting materials? Doesn't this indicate soldiers moved to or near ground zero shortly after a test may have received harmful beta exposure which would not have been measured either by available electronic equipment or by film badges?

ANSWER:

Fallout does contain beta-emitting isotopes, and the level of beta activity will vary with intensity, fractionation, and age of the fallout. It is possible that soldiers moving to or near ground zero shortly after a test could receive beta exposure not measured by available detection equipment. This exposure could be greater if these soldiers were on crawling maneuvers where the debris could more easily come in contact with the skin.

QUESTION:

During testimony on January 25th, Major Skerker stated that some personnel were authorized to receive radiation exposures higher than the permissible dose. Who were these personnel and in what capacities did they serve during the tests? Were they informed in advance, or after the fact, that they were authorized to receive higher than permissible doses? Was their consent sought? Were they informed of their actual exposures? What exposure levels did they suffer? Has there been any medical follow-up effort on these individuals prior to 1978?

ANSWER:

A complete answer to this question will have to await the completion of the DoD research effort.

It is apparent that some individuals were, in fact, authorized to receive radiation exposures in excess of the accepted dose standards. Examples are:

1. Members of the Officer Volunteer Program. These were uniformed service personnel, a part of the Desert Rock Troop Observer Program.

2. Some AEC employees and contractors under the direct cognizance of the AEC Test Manager who were to perform special tasks.

3. Air Force cloud-sampling teams under direct control of the Special Weapons Command (SWC).

Research to date has confirmed that some of these categories of personnel during some test events were informed in advance that they were authorized to receive higher doses, that they gave their consent, and that they knew their actual exposure levels. However, it is impossible at this time to state whether or not this is true for all individuals. It is expected that our research will provide answers to these and the other questions above. We are not currently aware of any medical follow-up prior to 1978.

QUESTION:

What is the recorded exposure level at which you intend to locate and notify a test participant for medical follow-up?

ANSWER:

Many different types of follow-up will be accomplished on various categories of personnel over the coming months and years. The type of medical follow-up most directly related to your question is as follows:

In cases of DoD personnel whose recorded exposure is above a given level, the Department of Defense will attempt to locate each individual, notify him of his exposure, and have him medically examined using a standardized, appropriate protocol. No final decision has yet been made as to the exposure level which will ultimately be used to trigger this type of notification and medical follow-up. The reason this issue is still open is that the necessary data upon which to make such a decision is still being gathered. Pending a final decision, notification and medical follow-up will be carried out for individuals whose recorded exposure level is in excess of 25 rems. This level represents the allowable emergency dose recommended by the Natinal Council on Radiation Protection and Measurements. (For example, NCRP Report No. 39 states: "Since planned whole-body doses up to 25 rems are reasonably accepted for emergency conditions, it follows that accidental doses up to the same magnitude should not cause major concern.") It is emphasized that selection of this level was an initial action, to allow notification and medical follow-up to commence without delay, prior to the availability of data upon which to make a final decision.

In addition to the above procedure, DoD notification and medical follow-up is being carried out for specific high-interest-groups; and medical follow-up will be accomplished by the National Research Council of the National Academy of Sciences and by the Center for Disease Control in their areas of research, depending upon their protocols and procedures.

QUESTION:

Have you considered locating and notifying all who were present at particularly suspect events--for instance, the Nancy blast as outlined by Major Skerker?

ANSWER:

Yes. Extensive and continuing consideration has been given to locating, notifying, and providing medical follow-up for all who were present at particularly "suspect" events. To date, it has been decided to do this for two events: the Air Force and Army personnel on Rongerik Atoll who were exposed to fallout; and the "Officer Volunteer Program" personnel who participated in some of the Nevada shots. Additional groups will be incorporated in this program if the circumstances appear to warrant it.

In addition, in discussions with the Medical Follow-up Agency of the NRC, serious consideration has been given to including events of greatest interest/concern in their study. For events selected by the NRC, numerous participants might well be contacted in the course of the research (depending upon the protocol and procedures).

Regardless of NRC action, and in addition to the "event" follow-up described in the first paragraph above, DoD plans to locate, notify, and provide medical follow-up to all personnel in the entire atmospheric nuclear test program whose recorded exposures are above a given level (see previous answer for discussion of this level).

QUESTION:

Have you considered locating and notifying others who might expect to have been exposed to significant radiation exposures, such as pilots who were flying radiation cloud sampling planes at the tests?

ANSWER:

Yes. As initial data is obtained upon participation and exposures of special groups, such as aircrews of cloud-sampling-aircraft, this data will be carefully reviewed to determine if circumstances warrant a specific notification and medical follow-up program, or if instead these procedures should be followed only in the case of individuals whose recorded or estimated doses exceeded a given level.

B. DEPARTMENT OF DEFENSE - QUESTIONS WITH RESPECT TO THE PRIVACY ACT

QUESTION:

What is the DoD's policy with respect to disclosing personal and/or medical records to another federal agency doing epidemiological research which has important public health implications?

ANSWER:

Disclosure of personal and/or medical records to another federal agency doing epidemiological research is governed by the requirements of DoD Directive 5400.11, Subject: Personal Privacy and Rights of Individuals Regarding Their Personal Records dated August 4, 1975. The Directive permits disclosure to someone other than the individual to whom the records pertain only under certain enumerated circumstances. The circumstances include dislosure to a person pursuant to a showing of compelling circumstances affecting the health or safety of an individual, if upon such disclosure notification is transmitted to the last known address of the individual to whom the record pertains. A federal agency doing epidemiological research would have to show compelling circumstances in order to permit disclosure of personnal and/or medical records, the preferable alternative to a determination of "compelling circumstances" would be to make the interested agency a routine user of the subject system.

QUESTION:

What is the process by which a request for such information under the authority of the Privacy Act is evaluated in DoD?

ANSWER:

The DoD component maintaining the record would handle the request for information in accordance with DoD Directive 5400.11 and its internal regulations implementing the Directive. For example, the Defense Nuclear

Agency has a Privacy Act Officer, with responsibility for serving as the principal point of contact on privacy matters and for establishing and maintaining an effective internal Privacy Program in compliance with DoD Directive 5400.11. A request for information would be submitted to the DNA Privacy Act Officer, who would evaluate the request and act on it in accordance with the statute and the published guidelines and regulations.

QUESTION:

What guidelines or criteria are used to evaluate the request?

ANSWER:

A request is evaluated on the basis of the DoD Directive, the component's internal regulations, OMB Guidelines, and if necessary, consultation with the Defense Privacy Board.

QUESTION:

How long does the process usually take to reach a decision on a request for personal and/or medical records under the Privacy Act?

ANSWER:

If the request is from the individual to whom the record pertains, the decision can be reached immediately. If the request is from another party, the decision is much more time-consuming--because the basic purpose of the Privacy Act is to prevent the release of this information, with certain exceptions. Unauthorized release is subject to criminal penalties. Thus the length of time for response in these latter cases would depend upon the nature of the request, the status of the party requesting information, whether or not there was a proper showing of compelling circumstances, the complexity of the legal issues, the location of the information, the backlog of requests, and numerous other factors.

QUESTION:

Who makes the final decision for DoD?

ANSWER:

The Privacy Act Officer for the component involved would make the final decision. If the release is not clearly warranted, the Privacy Act Officer would consult with the Defense Privacy Board. Any requirement for information from an individual which does not appear to be clearly authorized by law or Executive Order would be referred by the Defense

Privacy Board to the Office of the General Counsel, Department of Defense for resolution.

QUESTION:

Is there any opportunity for appeal or re-consideration?

ANSWER:

There are always opportunities for appeal or re-consideration. However, once the matter has been addressed by DoD the General Counsel, the Privacy Act Board and the component's Privacy Act Officer will act in accordance with the General Counsel's guidance.

QUESTION:

Has your authority to release personal and/or medical records changed over the last year? If so, how?

ANSWER:

The authority to release the subject information has not changed. The authority to release is still controlled by the Privacy Act of 1974, the DoD Directive, internal implementing regulations, and OMB Guidelines.

QUESTION:

Does DoD have a "routine use" listing for the record systems which the Center for Disease Control needs to conduct its epidemiologic study on "Smoky" participants?

If DoD does not have a "routine use" for such records, why not?

ANSWER:

The DoD does not at present have a "routine use" listing for the Center for Disease Control (CDC).

The system of records for which a routine use would be required has been developed by the Defense Nuclear Agency with assistance from other DoD components. The Defense Nuclear Agency has prepared a system notice for publication in the Federal Register. The notice is currently being reviewed by the Defense Privacy Board prior to sending to OMB for release to the Federal Register for publication for comment. CDC is listed as a routine user in the proposed notice but until the notice has been published and commented upon, CDC will not be able to access the subject system of records.

QUESTION:

Please examine the enclosed excerpt from the Federal Register which lists new and revised "routine use statements" for the Veterans Administration. Does DoD have any "routine use" listings comparable to #5? If not, why not?

ANSWER:

The DoD does not have any "routine use" listings comparable to #5, but one is being developed. See previous answer.

QUESTION:

Please cite any requests for personal and/or medical records by other federal agencies for the purpose of conducting epidemiological research which DoD has had in the past 3 years, and the actions taken on such requests, and the justification for such actions.

ANSWER:

The only known request, other than CDC (which is discussed later) occurred in the summer of 1976, when the State Department requested access to certain personal and/or medical records of the Department of the Air Force for the use of John Hopkins University, a State Department contractor. John Hopkins was performing a biostatistical study on all former staff of the United States Embassy in Moscow. The Air Force granted the request, and access was permitted under the routine use provision. We are continuing to look for other instances.

QUESTION:

Please provide a chronological list of the request (both formal and informal) made by the Center for Disease Control to DoD for information on "Smoky" and "Smoky" participants for the purpose of conducting an epidemiological study and a status report on which information has been provided, and which information has been denied and why. If any requests are pending, please indicate the date by which you expect a decision will be made.

ANSWER:

Answer will be provided by close of business 15 March 1978.

QUESTION:

Under the Privacy Act, section 552a(b) lists conditions of disclosure under which records may be disclosed to another agency without prior written consent of the individual(s) involved. In particular, condition (8) of section 552a(b) is:

> "to a person pursuant to a showing of compelling circumstances affecting the health or safety of an individual if upon such disclosure notification is transmitted to the last known address of such individual;"

Could the Center for Disease Control's request for DoD records of "Smoky" participants be authorized under condition #(8)? If not, why not?

ANSWER:

Answer will be provided by close of business 15 March 1978.

QUESTION:

Has the DoD ever contracted with another federal agency to do a study or project, and then disclosed personal and/or medical records by virtue of that contractual relationship, which might not otherwise be permitted to be disclosed under the Privacy Act? Could the DoD contract with the Center for Disease Control and thereby authorize the disclosure of the records which the C.D.C. needs to conduct its study on "Smoky" participants?

ANSWER:

a. To the best of DNA's knowledge, DoD has not contracted with another federal agency to do a study or project, and then disclosed records subject to the Privacy Act under such contract.

b. No. Current DoD policy requires that the Center for Disease Control be made a routine user of the records. This is in process.

QUESTION:

Does the National Academy of Sciences' National Research Council Medical Follow-up Agency have access to personal and/or medical records which federal agencies are not allowed? If so, why?

ANSWER:

No, NRC access, as is the access of any federal agency, would be controlled by the routine use provision of the system notice. In anticipation of NRC's work, they have been included as a routine user under the proposed system notice.

QUESTION:

Could DoD, if asked by another federal agency for the purpose of conducting epidemiological research, send information to the last known address for an individual (or individuals) on whom it has a file or record, to obtain permission for disclosure of such records?

ANSWER:

Yes, as a practical matter, however, making the federal agency a routine user of the record system would be less time consuming and more efficient.

Mr. ROGERS. Dr. Carter?

Mr. CARTER. Thank you, Mr. Chairman.

Commander Finkelstein, is he here? Are you a submariner?

Commander FINKELSTEIN. No, sir, I am a surface warfare officer.

Mr. CARTER. Sir?

Commander FINKELSTEIN. I am a surface warfare officer.

Mr. CARTER. Excuse me. I did not mean to——

Commander FINKELSTEIN. It is one of our new warfare qualification insignia that we have instituted in recent years.

Mr. CARTER. I am sorry. Certainly I do not think it would have been to your detriment to have said that.

Commander FINKELSTEIN. No, sir.

Mr. CARTER. Your services are both great, except in retrieval systems and recordkeeping.

By the way, commander, are you in the nuclear service?

Commander FINKELSTEIN. Sir, I am a line officer. If you are asking about my background, I hold degrees in electrical engineering, physics, and systems management.

Mr. CARTER. Do you serve on a nuclear powered ship?

Commander FINKELSTEIN. No, sir.

Mr. CARTER. Have you ever?

Commander FINKELSTEIN. No, sir, I have not.

Mr. CARTER. Have you ever had any training in nuclear warfare?

Commander FINKELSTEIN. I have been to a 1-week orientation course.

Mr. CARTER. Have you ever been around a nuclear reactor?

Commander FINKELSTEIN. Only as an observer. I have not worked with nuclear reactors.

Mr. CARTER. How long were you around this reactor?

Commander FINKELSTEIN. Sir?

Mr. CARTER. How long were you around this nuclear reactor?

Commander FINKELSTEIN. Oh, as I recall, 20 minutes out at AFRRI.

Mr. CARTER. Sir?

Commander FINKELSTEIN. Twenty minutes, one afternoon out at AFRRI.

Mr. CARTER. Admiral, what records do you keep of your men who are around nuclear reactors, for instance, on nulear power surface ships or on submarines?

Admiral MONROE. Naval propulsion, you are speaking of, sir.

Mr. CARTER. Sir?

Admiral MONROE. Naval propulsion, you are speaking of principally now?

Mr. CARTER. Naval propulsion?

Admiral MONROE. Nuclear——

Mr. CARTER. Nuclear propulsion.

Admiral MONROE. Nuclear propulsion of naval ships, yes, sir.

Mr. CARTER. Nuclearly propelled naval ships, yes, sir.

Admiral MONROE. At the Defense Nuclear Agency we keep none. However, I have here in the hearing room Rear Admiral Sparks of the Bureau of Medicine and Surgery, who, I believe, can respond to questions you may have about reactor safety and reactor radiological protection and health physics, if I may call him.

Mr. **Carter**. What I want to know, is whether any records are being kept?

Commander **Finkelstein**. I am familiar with that. There certainly are records being kept for the nuclear propulsion people.

Mr. **Carter**. Sir?

Commander **Finkelstein**. Yes, there are records kept on the nuclear propulsion people.

Mr. **Carter**. You are pretty familiar with that. I thought that was not your field. Did you not say you had a doctor here?

Admiral **Monroe**. Rear Admiral Sparks of the Navy's Bureau of Medicine and Surgery, the Operational Medicine Division, whom I believe will be able to address these questions.

Mr. **Carter**. Doctor, do you keep records of your men who are on nuclear subs and on nuclear surface ships?

Admiral **Sparks**. Yes, Doctor, we do.

Mr. **Carter**. Yes, sir.

Do you check on the causes of morbidity or illnesses, among these people who have served on such ships?

Admiral **Sparks**. We have done that; yes, sir.

Mr. **Carter**. And do you have those records readily available?

Admiral **Sparks**. I believe so.

Mr. **Carter**. The first ship that was in action, I believe, was an underseas ship called the *Nautilus*, is that right?

Admiral **Sparks**. I remember seeing that ship, yes, sir.

Mr. **Carter**. Yes, sir. Do you remember when it went into action?

Admiral **Sparks**. No, I cannot recall. I am not familiar with that.

Mr. **Carter**. Do you have records of those men who served on the *Nautilus?*

Admiral **Sparks**. I am sure they are available.

Mr. **Carter**. Yes, sir. And the men's morbidity records as well?

Admiral **Sparks**. Yes, sir.

Mr. **Carter**. And in case of death, could you find the causes of death of those men?

Admiral **Sparks**. That could be done.

Mr. **Carter**. I would like you to submit them to this committee, not only for the *Nautilus* but for, well, for all the submarine service, including nuclearly propelled submarines. Then you might compare them with those who have served on diesel powered ships alone. I would like to see that comparison; if you could include that for our record, I think it would be extremely helpful.

[The following information was supplied for the record:]

Status of the first crew of USS "Nautilus" (SSN-571)

	Crew members
Alive and well	94
Dead	[1] 2
Total	96

[1] One, lymphosarcoma—Rading: steward, radiation exposure: zero. One, arteriosclerotic heart disease—rating: torpedoman, radiation exposure: 0.82 rem.

Rate of all Diseases and Cancers Among Nuclear and Diesel Submariners[1]

	Crew members
Nuclear:	
All diseases	125
Cancers	1.19
Diesel:	
All diseases	184
Cancers	1.18

[1] Rate per 1,000 submariners.

From a population study of 56,000 active duty men during a 30-month period (July 1968-December 1970) who had over 4 years of either nuclear or diesel submarine duty only.

Summary: Nuclear submariners had less total diseases and no more cancers than diesel submariners.

Mr. CARTER. Admiral, you are familiar with nuclear propelled craft, I take it?

Admiral MONROE. Nuclear what, sir?

Mr. CARTER. Propelled craft.

Admiral MONROE. Not intimately, but, yes, sir.

Mr. CARTER. You are not a nuclear——

Admiral MONROE. No, sir.

Admiral SPARKS. Neither am I, Doctor. I am a physician.

Mr. CARTER. What happens when a core melts? You have another doctor there, maybe——

Admiral MONROE. I will have to provide that answer for the record, sir.

Mr. CARTER. Can you tell us what happens when the core melts?

Mr. HASS. When the nuclear reactor core melts, Dr. Carter, you have quite a nuclear accident. I am not aware that a core——

Mr. CARTER. To be frank, it blows the hinges off of hell, does it not?

Mr. HASS. I beg your pardon, sir?

Mr. CARTER. It would blow the hinges off of hell?

Mr. HASS. I would think so. I am not aware of any such incident in nuclear propulsion units.

Mr. CARTER. If you had a melting of a nuclear core, that is what would happen. And, in fact, it might affect people as far as 40 or 50 miles away.

Mr. HASS. I do not think so, Dr. Carter.

Mr. CARTER. It could, depending upon the size of the reactor.

Mr. HASS. I do not believe that would happen, Dr. Carter.

Mr. CARTER. Well, I would think so. It would not occur with a nuclear sub, because the reactor, would not be large enough; but with some of the nuclear reactors we are building in this country today, it is my understanding from scientists that the explosion could affect people as far as 45 to 50 miles away.

Mr. HASS. Dr. Carter, none of us here at the table are nuclear reactor specialists, but I do not believe that the melt-down of a nuclear reactor core——

Mr. CARTER. Well, if you are not specialists, then your beliefs are not very meaningful.

All right. Now, Admiral, after 31 years, we are going to march off smartly in this.

Admiral MONROE. That is correct, sir.

Mr. CARTER. After 31 years.

I do not know. I do not think that your people are particularly the cause of many of the accidents which we have had. It was a case in which you did not know, and things have occurred which are regrettable.

Now, again, regardless of how complete the 1968 compilation is, the point of all this is that in 1970 the Department of Defense knew that thousands of personnel had been exposed to radiation and that some had died of leukemia, according to the letter that we have right here. Yet nothing was done so that in April 1977, this situation was considered a surprise. We have a copy of the letter from Congressman Olin Teague to Mel Laird, Secretary of Defense: Yet 7 years later, we come back and most of the services do not have these records compiled, the Air Force excepted, although the Marine Corps is making a valiant effort, it seems.

Thank you, Mr. Chairman.

Mr. ROGERS. Dr. Haas, were you in the Department of Defense in May 1970, January 1970?

Mr. HASS. Yes, I was, Mr. Chairman.

Mr. ROGERS. Were you aware of the letter to the Secretary from Mr. Teague?

Mr. HASS. I was not, Mr. Chairman.

Mr. ROGERS. What position were you in at that time?

Mr. HASS. I was, at that time, the Assistant to the Deputy Director for Science and Technology of the Defense Nuclear Agency. The letter apparently was answered by Dr. Walske in the Office of the Secretary of Defense and, in all probability, neither it nor the original letter to Secretary Laird was forwarded to the Defense Nuclear Agency.

Even if it had been, it would not necessarily have come to my attention, but it may well have been.

Mr. ROGERS. While you were there you recall no action taken by your agency in response to Congressman Teague's alert?

Mr. HASS. Well, the answer that you had, Mr. Chairman, that Dr. Walske gave, does not give me any indication that the Defense Nuclear Agency, or its predecessor, the Defense Atomic Support Agency, was, indeed, consulted in the matter. As best as I can tell, Dr. Walske, who holds the additional position of chairman of the Military Liaison Committee to the Department of Energy, consulted with the Atomic Energy Commission at that time, and not with the Defense Nuclear Agency. But I cannot confirm that for sure, but we will search our records.

Mr. ROGERS. Would you let us know, then?

Mr. HASS. Yes, we will.

Mr. ROGERS. I would have thought it would be natural for him to at least have consulted with his own agency before going outside. Would that not have been the normal practice?

Mr. HASS. Well, if it had not been for the fact, Mr. Chairman, that Dr. Walske held this additional position of being the chairman of the Military Liaison Committee which is a statutory position, to the Atomic Energy Commission, that would be true. So it was not really going outside, so to speak, and it would have been perfectly appropriate for him to indeed go to the AEC. But he may well have gone to the Defense Nuclear Agency. We will provide that answer.

Mr. ROGERS. But, in any event, a judgment was made that no followup was needed?

Mr. HASS. It appears that way.

Mr. ROGERS. By the Department of Defense?

Admiral MONROE. So it appears, sir.

Mr. ROGERS. Would you let us know if there are any records bearing on this?

Admiral MONROE. Yes, sir, I surely will.

Mr. ROGERS. Either pro or con.

[The following information was received for the record:]

ACTION TAKEN REGARDING CONGRESSMAN TEAGUE'S LETTER OF JANUARY 8, 1970

An extensive search has been made of the records of the Assistant to the Secretary of Defense (Atomic Energy)—Dr. Carl Walske's office—including inactive records which have been moved to holding areas outside the Pentagon. No files bearing on the response to Congressman Teague's letter have been located to date, but the search is continuing.

To provide the subcommittee with a clearer picture of the work done in 1970, the following summary is provided. It is based upon the recollection of some of the individuals involved. Congressman Teague's letter of January 8, 1970, was referred for action to Dr. Walske's ATSD(AE) office. Dr. Walske had the matter researched for several months prior to responding to Congressman Teague in his letter of May 15, 1970. The research was accomplished primarily by Dr. Walske's ATSD(AE) staff. The AEC and the Military Departments also provided significant assistance. There was little or no involvement by the Defense Atomic Support Agency (DASA)—the predecessor organization of today's Defense Nuclear Agency.

As a result of this query by Congressman Teague and the resulting research, the Assistant to the Secretary of Defense (Atomic Energy) established a centralized file of records on radiation exposure data for DOD personnel. Previously this exposure information had been widely scattered in many individual repositories. The centralized data were combined with the existing AEC files at their Nevada office (the REECO files). Agreements were reached between DOD, the AEC, and the VA that this file could serve all users. It was estimated that some 80 percent of the readily available DOD exposure records were entered into these centralized files. Note, however, that this effort did not extend to locating exposure data in individual service records or medical records. Upon completion of this effort, and with the establishment of this permanent file upon which the VA could draw, the ATSD(AE) effort in response to Congressman Teague's query was completed.

The REECO files still exist, and still serve the purpose for which they were established. For example, the VA still goes to them for exposure data in individual cases. However, while these REECO files will be of assistance in the current DOD effort, they are of limited utility for several reasons: First, you must enter the files with an individual's name (you will recall, in the case of Dr. Caldwell's CDC investigation of shot "Smoky," the need for names was a limiting factor). Second, the files do not distinguish between DOD and AEC, military and civilian, et cetera. Third, one individual, who might have been film badged on several occasions, may be in the files in several locations (for example, once as Joe Smith, again as Joseph Smith, later as J. V. Smith)—each with a separate exposure—and careful manual work is required to attempt to correlate these.

In summary, while the 1970 effort was an extensive one, and was felt to have served its purpose, it is really only a starting point for the present much broader effort.

Admiral MONROE. I might add one amplifying bit of information. The Department of Defense does conduct extensive research and studies in high levels of ionizing radiation: Hundreds of rads, thousands of rads. We do this at the Armed Force Radiobiology Research Institute. That is their principal mission. We do not do any studies in low-level ionizing radiation. Those are done by the Department of Energy and the Public Health Service, to my understanding, within the U.S. Government.

Thus, since this query that Dr. Walske received from Mr. Teague dealt with the possible effect of low-level ionizing radiation, it would have been more likely that he would have discussed it with the Department of Energy through his——

Mr. CARTER. Mr. Chairman, I would just like to interrupt the admiral. He is evidently a very nice gentleman, and all of you gentlemen are very fine men, but since all this study, I sent about—and I know it is difficult to find these men since 1945 and 1946 and so on, since Los Alamos. And for that reason—I know it is difficult for you to do that—but I have a list of Quantrill's guerrillas, the group that raided Lawrence, Kans., during the Civil War. Here are their names. Do you mean to tell me that you cannot get the names of the men who served in your forces in an expeditious manner? I just do not know what to think.

It beggars the imagination to say that you do not have the names and figures on morbidity and mortality for the people who are around nuclear reactors. I am surprised. Here is the list I mentioned of Quantrill's raiders. I would be glad for you to see it. Look it over. I may have some relatives in the group.

Thank you, Mr. Chairman.

Mr. ROGERS. Well I do not think that Congressman Teague's letter went into the problem of research that you may be doing. I think he was talking about exposure, Admiral. Now, Captain, are you aware of any problem with exposure to low-level radiation?

Captain TYLER. I have been aware for many years of radiation hazards. Everybody is aware that high-level radiation has biological effects, serious biological effects, up to lethality. I think Dr. Jablon earlier pointed out that our real problem in the scientific community is exactly what do we call low-level effects. Is it a linear effect down to zero? Is there a threshold?

The majority of the people think there is a linear effect, but is it a straight line or curvilinear. This is the real, unknown area. This is where AEC, now DOE, and Public Health Service research has been concentrated. ONA and the Armed Forces Radiobiology Research Institute to date have been primarily looking at the acute problem of high-dose radiation on military personnel regarding weapons used in combat.

We were always aware of the large controversy. Concerning low level effects. I think, now that it has been brought to our attention, it is amazing why somebody else, either in our organization or elsewhere, has not thought of looking at these troops in the last 30 years. If we are successful with this study, we have an excellent body of people that may add further to the scientific knowledge of low-level effects.

They have done extensive studies in the Japanese, the Marshall Islands group, and now we have a brand new body that is probably as extensive as the Japanese group. Certainly with the right kind of data, the right followup, I think this may put another nail into what are, if any, the low-level effects and what is their significance.

Mr. ROGERS. I am concerned that the Department did not react in 1970, even, when this was specifically brought to their attention. I know you probably were not there.

The committee will contact Dr. Walske if he is still living. Does anyone know if Dr. Walske is still living?

Mr. HAAS. At the last itme I know Dr. Carl Walske, he resided in New York City and I believe he was the president of an organization dealing with largely nuclear power, I forget the name of it.

Mr. ROGERS. But as far as you know, he is still alive?

Mr. HAAS. Oh, definitely.

Mr. ROGERS. We will ask the staff to contact Dr. Walske and see if he made that judgment by himself. It would be helpful if you could also give us any records that you have.

Admiral MONROE. Certainly.

Mr. ROGERS. Then, too, Admiral, will you furnish the committee on a weekly basis with what is being done and how many people have contacted the Department.

Admiral MONROE. Yes, sir.

Mr. ROGERS. You have given us a report that 2,500 have already contacted you by telephone. Do we know how many by mail, and so forth? Who is coordinating that?

Admiral MONROE. We are, sir. The telephone effort has been underway for—we are into the 6th day, now. We have a computerized data base. We are organizing the data so that we can recall it by shot, by service, by exposure as we get it. We are responding to the calls with letters. We are also receiving, as you say, letters as well, and these are going into the data base.

Mr. ROGERS. How many letters have you received.

Admiral MONROE. I will have to provide that for the record, sir.

[The following information was received for the record:]

As of February 14, 1978, we have received 645 letters.

Mr. ROGERS. All right.

Mr. CARTER. I just want to say, gentlemen, that I trust that the men in the different services, are lean, fit, trim, able, and ready. I trust that you are preparing them well. I would hate to see our services go down.

You know, I guess you think that we have given you a hard time. As it happens, I have voted for every military appropriation over the years for many, many years. I try to be helpful to you. I just hope that you will be effective and able to defend this great country of ours.

Mr. ROGERS. Admiral, thank you very much.

Admiral MONROE. Thank you, sir.

Mr. ROGERS. If you would keep in touch and furnish us with the necessary materials.

Admiral MONROE. Yes, sir.

Mr. ROGERS. Thank you, gentlemen.

The next witness will be Mr. Donald Kerr, Acting Assistant Secretary for Defense programs, Department of Energy.

Dr. Kerr, we apologize for being late. We appreciate your patience.

Actually, we just want an update, Dr. Kerr, on what has happened now and what actions are being taken by the Department of Energy. Your statement will be made a part of the record in full, without objection. If you could highlight it for us, this would be helpful.

STATEMENT OF DONALD M. KERR, PH. D., ACTING ASSISTANT SECRETARY FOR DEFENSE PROGRAMS, DEPARTMENT OF ENERGY, ACCOMPANIED BY HAL HOLLISTER, DIRECTOR, DIVISION OF OPERATIONAL AND ENVIRONMENTAL SAFETY; GORDON JACKS, LOS ALAMOS SCIENTIFIC LABORATORY, NEVADA TEST SITE: AND BRUCE CHURCH, BRANCH CHIEF FOR RADIATION SAFETY, NEVADA OPERATIONS OFFICE

Dr. KERR. Thank you, Mr. Chairman and members of the committee. I am pleased to reappear before you today to outline those things that we have done within the Department of Energy, and are still doing, in response to the many questions and requests that were posed by this committee during my testimony at the hearings on January 26, 1978. I have brought back with me today three other individuals who may be helpful in areas where I would be unqualified to respond to questions.

On my right is Mr. Hal Hollister, Director of the Division of Operational and Environmental Safety to assist if there are questions regarding the health consequences or environmental aspects of operational procedures.

Mr. ROGERS. Thank you, Mr. Hollister.

Dr. KERR. Mr. Gordon Jacks has returned from the Los Alamos scientific laboratory where he is the senior member of the permanent LASL party at the Nevada test site. He has been involved with radiological safety programs associated with nuclear testing since 1956.

Mr. ROGERS. Mr. Jacks, we welcome you back.

Dr. KERR. And finally, Mr. Bruce Church, sitting next to Mr. Jacks, is Chief of the Radiological Branch at the Nevada Operations Office and in that position he is responsible for radiological safety at the best site. In addition, he is directing the review of exposure records from past nuclear testing.

On February 8, I provided for this commitee written answers to 15 of the 25 questions that had been raised on January 26. Today I am submitting for the record information on the other 10 questions and will tell you about further actions we will be taking in order to furnish you with additional information by the 29th of March. If there are added concerns with regard to the information that we have supplied, we will try to answer your questions today.

I will now try to highlight a few points from the prepared statement, in the interests of time. [See p. 1140.]

I would like to make one comment with regard to the health effects research projects which have been conducted during the last 10 years. On February 8, I provided a list of that work which is now in progress, in fiscal year 1978. Today, I am adding for the record the complete tabulation of the funding of those projects over the 10-year period of interest to the committee.

An additional point added for the record is the complete set of radiation exposure guidelines from 1946 to the present. They were based upon the best biomedical advice that was then available. The guidelines of the National Council on Radiation Protection and Measurements—pre-1959—and subsequently of the Federal Radiation Council for the period 1959 to 1970 were followed explicitly. Since 1970, the Environmental Protection Agency has been responsible within the Government for setting standards.

In my detailed answer, I have provided a summary table showing what those guidelines were and where they were published.

When I last appeared before you, the Baneberry test occupied a great deal of your attention. I would like to review several points from that in order to make sure your understanding and our attempt to help it have succeeded.

The test, as you know, was detonated on December 18, 1970, in Yucca Flats. It was a 10 kiloton device buried at a depth of 912 feet.

Venting was noted visually at about 7:33 a.m. Approximately 900 persons were located in the forward areas of the test site at the area 12 camp, about 4 miles from the Baneberry ground zero, and in the tunnel areas about 2 miles beyond the area 12 camp. Evacuation of these persons was ordered at 9:05 a.m. and was completed about 9:15 a.m.

When the evacuation of these personnel commenced, vehicles used in the evacuation were joined in a convoy in area 17 before traveling to the control point for monitoring and decontamination as necessary. A total of 475 vehicles were monitored at the control point on the day of the event as counted by security personnel. There were 413 contaminated vehicles, decontamination and release of 380 was accomplished, and 33 vehicles were impounded pending decay of radioactivity.

Personnel were monitored while their vehicles were monitored. Personnel with detectable contamination were taken into the radsafe building CP-2 for additional monitoring and superficial decontamination, including brushing and use of tape patches to remove slight contamination.

Clothing was taken from 106 persons and those personnel were monitored for skin and hair contamination, decontaminated by showering, if necessary, and provided clean clothing. Of the 106 persons, 86 were required to shower. After remonitoring, 68 were sent to Mercury for additional decontamination and direct measurement of thyroid radioactivity.

Urine samples were taken and analyzed for many of these personnel. Of the personnel thyroid-counted in Mercury, 18 were sent to EPA in Las Vegas where wholebody counts were performed.

Of the 86 persons that were decontaminated, 43 are presently employed by DOE contractors or laboratories.

After evaluating all film badge results, thyroid counts, wholebody counts and urine sample results, it was concluded that no individual received external or internal dose in excess of AEC exposure guides in effect at the time.

Three persons known or purported to have been exposed from the Baneberry event have contracted leukemia. Information concerning these individuals and their Baneberry radiation exposure records is summarized.

H. R. Roberts, a WSI security guard received 900 millirem wholebody gamma, determined from evaluation of his contaminated film badge which indicated 1,045 millirem gamma and 4,435 millirem beta dose to the skin, both of which included contamination darkening of the dosimeter film, and 3,680 millirem to the thyroid during the Baneberry event. He received no reportable radiation doses at NTS after the Baneberry event as determined by film badge dosimetry.

W. H. Nunamaker, a REECO employee, received gamma doses during the Baneberry event of 105 millirem whole-body gamma, 430 millirem beta dose to the skin——

Mr. Carter. Mr. Chairman?

Mr. Rogers. Yes, sir.

Mr. Carter. Let's make it clear that when we are talking about 100 millirem, that we mean one-tenth of a rem. When we say 400 millirems, that means four-tenths of a rem.

Dr. Kerr. Thank you, Dr. Carter.

And finally, he received 650 millirem to the thyroid. He received no additional radiation dose at NTS after the Baneberry event.

W. C. Reed, a REECO employee, received no reportable radiation exposure from the Baneberry event as determined dosimetry. He was not among the group of personnel found to be contaminated, decontaminated, or thyroid-counted after Baneberry. His total dose at the Nevada test site after Baneberry was 40 millirem gamma, determined by film badge dosimetry.

It is noted that Mr. Reed was working in the forward NTS area during Baneberry, but his specific work location or whether he was in the Area 12 Camp is not known at this time.

One other person known to have been in the Area 12 Camp during Baneberry is now deceased from a lymphoma. P. A. Crawford, a REECO employee, received no reportable exposure during the Baneberry event. Monitoring personnel found a spot of contamination on one sleeve, which was removed. His clothing was not removed, he was not required to shower, and he was not thyroid-counted.

His total exposure at the test site after Baneberry was 40 millirem gamma. About 10 weeks before the Baneberry event, on October 5, 1970, a REECO physician had reported on a rehire physical exam sheet for Mr. Crawford, the presence of a palpable, bilateral lymph glands, a possible prelymphomic condition.

I previously testified to you with respect to changes in operational procedures after Baneberry. I will not repeat that now in the interests of time.

The committee asked that the Department of Energy go over the issues and cases of individuals mentioned by Dorothy B. Jones from the steering committee of Another Mother for Peace, and that we address the issues and comment about agency responsibility for the individuals involved.

The Department has examined the information furnished by Mrs. Jones. That information suggests that all of the persons whom she mentioned were, at the times of their respective exposures, members of the U.S. Armed Forces. DOE searched its REECO dosimetry records and that search turned up radiation exposure information about four of the seven individuals. No radiation exposure records were found for the other three.

DOE cannot comment on the various malpractices and acts of neglect which she has alleged to have taken place within the military forces. Any comment on these matters should come from the DOD.

Mrs. Jones stated in her testimony that, and I quote: "There is, and has been for years, a coverup by the DOD, the AEC, and the Veterans' Administration, a consistent attempt at many levels to deny to the victims medical records, verification of their presence at certain tests and other information essential to their receiving rightful service-connected benefits."

I must comment emphatically that there is no attempt on the part of the Department of Energy to withhold any information from an individual about his participation in nuclear testing. The people of whom Mrs. Jones has spoken, or any person, may obtain information about his radiation exposure history by sending a signed request to the Department of Energy's Nevada Operations Office, Post Office Box 14100, Las Vegas, Nev. 89114.

In making such a request, they must attach a copy of a valid identification document and they must, of course, furnish sufficient information about themselves and about the approximate date of exposure so that the exposure records can be seached.

For any of the individuals that Mrs. Jones mentioned who are seeking legal remedies because of exposures to radiation which occurred while they were in an active military status, they must make a claim against the U.S. Government to the Veterans' Administration under title 38, United States Code, section 331 and implementing regulations stemming therefrom.

Mrs. Jones proposed that the Department should make public the names of all individuals whose exposure records appear in its REECO files. Such an action would not be permissible under the Privacy Act, nor does there appear to be any useful purpose to be served if such a disclosure were arranged.

I will conclude by briefly telling you of the followup actions that we have instituted.

The present Department guidelines for radiation exposure are published in manual chapter 0524, Standards for Radiation Protection, most recently updated on March 30, 1977. The overall philosophy is for operations to be conducted in a manner to assure that radiation exposure to individuals and population groups is limited to the lowest levels practicable.

As applied to the Nevada test site, manual chapter 0524 requires that onsite exposures be limited to 3 rem per quarter and 5 rem per year and offside exposures be less than 170 millirem per year for unprotected populations and 500 millirem per year for controlled populations.

Medical followup of radiation exposures incident to nuclear testing has been required since October 4, 1971. In the most recent update of the Nevada Operations Office Manual Chapter 0528, occupational medical program dated February 3, 1977, an immediate physical examination, coupled with a medical followup program, is called for when an individual has been subjected to any of the following: Radiation exposure above manual chapter 0524 guidelines; more than 10 percent of allowable organ or body burden; more than 50 percent of allowable lung burden; radioactive contamination of open wounds; and skin damage or clinical symptoms indicating radiation exposure.

Further, a complete termination physical is required when such an individual leaves the Department of Energy or one of its contractor's employment. At present, there is no requirement for long-term followup after workers terminate.

As a further extension of the policies embodied in manual chapters 0524 and 0528, the Department is offering a medical examination to any present or former employee of AEC, ERDA or the DOE and its contractors who has a documented past radiation exposure for nuclear weapons testing above the current guidelines of 5 rem per year or 3 rem per quarter for radiation workers and who did not receive medical attention comparable to that now provided to NTS workers.

From the information which Dr. Caldwell and others have furnished this committee, it appears that there may be a need for an independent investigation of the disease histories among those present at nuclear tests. As I indicated in my testimony on January 26, the Department of Energy is planning to support, in conjunction with the Department of Defense and the Veterans' Administration an independent investigation conducted by the National Academy of Sciences. At the same time, we believe that it is desirable that the work of Dr. Caldwell be continued in parallel with whatever work is done by the Academy. We feel very strongly that such studies be conducted and managed outside of the programmatic concerns of the Department of Energy and the Department of Defense.

To assist such studies, we are publishing this week in the Federal Register a proposed revision to our Privacy Act System known as ERDA-30 to provide additional routine uses of the exposure record information in that system. This revision would permit disclosure of certain specific personnel dosimetry information for study purposes to the Department of Defense, the Center for Disease Control, and the National Academy of Science.

This should facilitate the followup epidemiological work concerning personnel exposures on Event Smoky and on other events where meaningful exposure information may exist.

Mr. Chairman, this completes the statement I would like to make now. I will submit the complete one to the record along with the detailed information attached to the copies which I have provided to the committee. As I indicated in my February 8 letter to you, we expect to complete our responses to your questions requiring an extensive review of our radiation exposure and health records by about March 29, 1978 and will then submit that material for the record.

I will be happy to try and answer any questions you may have.

[Testimony resumes on p. 1171.]

[Dr. Kerr's prepared statement and attachments follow:]

STATEMENT OF
DONALD M. KERR

Mr. Chairman and Members of the Committee:

I am pleased to reappear before this Committee to outline those things that we have done within the Department of Energy and are still doing in response to the many questions and requests that were posed by this Committee during my testimony at the hearings on January 26, 1978. I have brought back with me today three other individuals who may be helpful in areas where I would be unqualified to respond to questions.

Mr. Hal Hollister, who is Director of the Division of Operational and Environmental Safety, is here to assist if there are questions regarding the health consequences or environmental aspects of operational procedures.

Mr. Gordon Jacks is here from the Los Alamos Scientific Laboratory, where he is a senior member of the permanent LASL party at the Nevada Test Site. He has been involved with radiological safety programs associated with nuclear testing since 1956.

Mr. Bruce Church is Chief of the Radiological Branch of the Nevada Operations Office, and in that position is responsible for day-to-day radiological safety at the Nevada Test Site. He is directing the review of exposure records from past nuclear testing.

On February 8, 1978, I provided for this Committee written answers to 15 of the 25 questions that had been raised during the January 26 hearings. Today we are submitting information on the other 10 questions, and I will be telling you about further actions we will be taking in order to furnish you with additional information by about March 29, 1978. If there are additional concerns with regard to the information that we have supplied you in response to your questions, we will try to answer them for you here today.

I would like to make one brief comment with regard to the research projects related to low-level radiation effects which have been conducted during the last ten years. On February 8, I provided a list of that work which is now in progress. I would like to add for the record a complete tabulation of all research in the areas of interest that has been conducted by DOE and its predecessors during the last ten years.

I would like to provide some additional comments relative to your questions about radiological protection throughout the various test series for those people who were under the cognizance of the Joint Task Forces in the Pacific or of the AEC Test Managers for the test programs at Nevada. In my earlier testimony and in responding for the record to several of your questions, I described in some detail the radiation safety programs that were used during the various test series. I pointed out that for NTS tests after 1952, these radiation safety programs would not apply to Desert Rock exercise participation. While these programs evolved form year-to year and differed in some respects between the Pacific tests and those at the NTS, in each case, the programs were guided by the four basic principles used to control external exposure: time, distance, shielding and record keeping. These principles are then translated into radiological safety operational procedures. Typically, a controlled radiation area is established by monitors, surveying and posting warning signs. Entry into controlled areas is closely supervised, with personnel being accompanied by monitors who record time integrated doses for the express purpose of keeping personnel exposures to a minimum.

To minimize personnel contamination and internal deposition, personnel entering contaminated areas are dressed out as required in coveralls, boots, gloves, and respiratory equipment. These general procedures have been followed since testing began. It should be emphasized that maintaining records is a prime procedure in preventing excessive exposures.

For test operations under the control of either the AEC Test Manager in the Continental U.S. or a Joint Task Force Commander in the Pacific, briefings regarding the hazards unique to the detonations were the responsibility of the leaders of the participating organizations. Safety indoctrinations concerning eye burn hazards and radiological hazards were a requirement and were conducted. For example, publications such as the "Radiological Safety Handbook for Nevada Test Site," 1957, were provided and used.

Groups reentering the controlled area after an event were briefed on radiological conditions. The "Plumbbob On-Site Rad-Safety Report," 1957, states "after issuance of access permits, personnel were briefed on radiological conditions in the areas they intended to visit or work, and advised on the anti-contamination clothing and equipment required."

The "Final Report, Operation IVY, JTF 132, 1952," indicates two general levels of briefings were provided for Pacific operations: basic indoctrination, and technical training. The indoctrination included primarily nontechnical instruction in radiological safety measures and techniques. This indoctrination was given to all personnel of the Task Force. Technical training was given to the majority of the personnel who would staff the Task Force radiological organization.

Reentry into the controlled area after each detonation depended on the radiological situation. This was the case regardless of the test location, Nevada or the Pacific. The governing factor was the radiation dose allowed for the particular function to be performed. Since radiation exposure is dependent upon the time spent in the radiation and the dose rate, different times of entry would be considered permissible depending upon the expected length of exposure and existing dose rate.

The maximum permissible exposure allowed during the various weapons test operations varied, in general, from 3.9 R per 13-week period to 3.0 R per 13 weeks. When it was expected that the operational period would exceed 13 weeks, the maximum exposure was increased to a total of 7.8 R to 7.0 R for the entire operational period. During the later operations, such as PLUMBBOB, HARDTACK, and DOMINIC, the maximum permissible exposure for the operational period was limited to 5.0 R. These guidelines are being furnished for the record for each test series from 1946 to the present. They were based upon the best biomedical advice that was then available. The guidelines* of the National Council on Radiation Protection and Measurements (pre-1959) and subsequently of the Federal Radiation Council (1959-1970) were followed explicitly. Since 1970, the Environmental Protection Agency has been responsible within the Government for setting standards.

Radiological safety initial survey teams were the first to enter the test area shortly after the detonation, usually within two to three hours in the Pacific and sooner at the NTS. These teams used radio-equipped vehicles or helicopters, and determined the radiological situation using portable measuring instruments. Maps were then prepared from this information and dose rate contours plotted. This dose rate information was then used in briefing reentry and recovery parties and determining the time at which those parties could enter the controlled area.

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*The guidelines were actually published by the National Bureau of Standards in their handbook series.

The dosimetry program, as described in my earlier testimony and in further detail in material submitted February 8 to the Committee, was set up to measure and keep track of the radiation exposures of test participants. The primary radiation dosage measuring device used was the film badge; pocket dosimeters were routinely worn by reentry personnel but they were used primarily to determine the promptness with which the film badge should be processed. That is, if the pocket dosimeter indicated a significant dosage received by the individual, such as 500mR or above, the film badge worn by the individual was usually processed and read immediately rather than waiting until later in the day. Each film badge had an identifying number embossed on the film, and records were maintained of individuals issued each film badge. When the film badge records indicated that an individual was approaching, or had exceeded, the permissible exposure limit, that individual was no longer allowed to enter a radiation area. A determined effort was made to follow the exposure records closely to prevent anyone from exceeding the permissible exposure limit.

BANEBERRY

I would now like to turn to the BANEBERRY underground nuclear test which was conducted on December 18, 1970, at 7:30 a.m. in Yucca Flats, Nevada Test Site. It was a 10 kiloton device buried at a depth of 912 feet.

Dynamic venting (release of radiation) was noted visually at 7:33 a.m Approximately 900 persons were located in the forward areas at Area 12 Camp, about 4 miles from the BANEBERRY ground zero, and in the tunnel areas about 2 miles beyond the Area 12 Camp. Evacuation of these persons was ordered at 8:05 a.m. and was completed about 9:15 a.m. When the evacuation of these personnel commenced, vehicles used in the evacuation were joined in a convoy in Area 17 before traveling to the Control Point for monitoring and decontamination as necessary. A total of 475 vehicles were monitored at the Control Point on the day of the event (by security personnel count), 413 were contaminated, decontamination and release of 380 was accomplished, and 33 vehicles were impounded pending decay of radioactivity.

Personnel were monitored while their vehicles were monitored. Personnel with detectable contamination were taken into the Rad-Safe Building CP-2 for additional monitoring and superficial decontamination, including brushing and use of tape patches to remove slight contamination. Clothing was taken from 106 persons, and these personnel were monitored for skin and hair contamination, decontaminated by showering if necessary, and provided clean clothing. Of the 106 persons, 86 were required to shower. After remonitoring, 68 were sent to Mercury for additional decontamination and direct measurement of thyroid radioactivity. Urine samples were taken and analyzed for many of these personnel. Of the personnel thyroid-counted in Mercury, 18 were sent to EPA in Las Vegas where whole-body counts were performed.

Of the 86 people that were decontaminated, 43 are presently employed by DOE contractors or laboratories.

After evaluating all film badge results, thyroid counts, whole-body counts, and urine sample results, it was concluded that no individuals received external or internal dose in excess of the AEC exposure guides. The whole-body penetrating radiation guides (AECM-0524) during BANEBERRY were 3 rem per calendar quarter, 5 rem per year, and a cumulative exposure of 5 (n-18) rem (where n is the person's age in years). The guide in effect for the skin of the whole-body and the thyroid was 10 rem per quarter and 30 rem per year, respectively.

Three persons known or purported to have been exposed to radioactivity from the BANEBERRY event have reportedly contracted leukemia. Information concerning these individuals and their BANEBERRY radiation exposure records is summarized below:

A. H. R. Roberts, a WSI security guard, received 900 mrem* whole-body gamma (determined from evaluation of his contaminated film badge which indicated 1045 mrem), 4435 mrem beta dose to the skin (including contamination darkening of the dosimeter film), and 3680 mrem to the thyroid during the BANEBERRY event. He received no reportable radiation doses at NTS after the BANEBERRY event as determined by film badge dosimetry.

B. W. H. Nunamaker, a REECo employee, received gamma doses during the BANEBERRY event of 105 mrem whole-body gamma, 430 mrem beta dose to the skin, and 650 mrem to the thyroid. He received no additional radiation dose at NTS after the BANEBERRY event.

C. W. C. Reed, a REECo employee, received no reportable radiation exposure from the BANEBERRY event as determined by film badge dosimetry. He was not among the group of personnel found to be contaminated, decontaminated, or thyroid-counted after BANEBERRY. His total dose at NTS after BANEBERRY was 40 mrem gamma determined by film badge dosimetry.

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*Previously given in testimony as "980 mrem" at page 3-31 of transcript.

It is noted that Mr. Reed is known to have been working in the forward NTS area during BANEBERRY, but his specific work location or whether he was in the Area 12 Camp is not known at this time.

One other person known to have been in the Area 12 Camp during BANEBERRY is now deceased from a lymphoma. P. A. Crawford, a REECo employee, received no reportable exposure during the BANEBERRY event. Monitoring personnel found a spot of contamination on one sleeve, which was removed. His clothing was not removed, he was not required to shower, and he was not thyroid-counted. His total exposure at NTS after BANEBERRY was 40 mrem gamma. About 10 weeks before the BANEBERRY event, on October 5, 1970, a REECo physician had reported on a rehire physical exam sheet for Mr. Crawford the presence of palpable, bilateral lymph glands, a possible pre-lymphomic condition.

In our opinion, there is no causal relation between the exposure to small amounts of radiation received by these individuals and their subsequent illness and death from leukemia.

On the basis of the BANEBERRY experience and investigation, the Commission took action to strengthen technical and administrative procedures to substantially reduce the probability of a similar future occurrence. Those actions included but were not limited to more extensive geologic and geophysical investigations; the institution of more conservative area controls and restriction of forward area personnel and facilities to minimum requirements; and a more vigorous analytical program so as to better understand the behavior of nuclear detonations in the various environments which may be encountered in emplacing underground tests, with special emphasis on more conservative burial depth for low yield experiments. As a result of these actions, there has been no significant amount of radioactivity detected on the ground outside the Nevada Test Site since that date.

ANOTHER MOTHER FOR PEACE INFORMATION

The Committee asked that DOE go over the issues and cases of individuals mentioned by Dorothy B. Jones from the Steering Committee of Another Mother for Peace and that we address the issues and comment about agency responsibility for the individuals involved.

The Department has examined the information furnished by Mrs. Jones. That information suggests that all of the persons whom she mentioned were, at the times of their respective exposures, members of the U.S. Armed Forces.

DOE searched its REECo dosimetry records and that search turned up radiation exposure information about four of the seven individuals. No radiation exposure records were found for the other three.

DOE cannot comment on the various malpractices and acts of neglect which she has alleged to have taken place within the military forces. Any comment on these matters should come from the DOD.

Mrs. Jones stated in her testimony that "...there is and has been for years a cover-up by the DOD, the AEC and the Veterans Administration--a consistent attempt at many levels to deny to the victims medical records, verification of their presence at certain tests and other information essential to their receiving rightful service-connected benefits."

I must comment emphatically that there is no attempt on the part of DOE to withhold any information from an individual about his participation in nuclear testing. The people of whom Mrs. Jones has spoken or any person may obtain infromation about his radiation exposure history by sending a signed request to the Department of Energy's Nevada Operations Office, Post Office Box 14100, Las Vegas, Nevada 89114.

In making such a request they must attach a copy of a valid identification document, and they must, of course, furnish sufficient information about themselves and about the approximate date of exposure so that the exposure records can be searched.

For any of the individuals Mrs. Jones mentioned who are seeking legal remedies because of exposures to radiation which occurred while they were in an active military status, they must make a claim against the United States Government to the Veterans Administration under 38 U.S.C. 331 _et_ _seq._ and implementing regulations.

Mrs. Jones proposed that DOE should make public the names of all individuals whose exposure records appear in its REECo files. Such an action would not be permissible under the Privacy Act, nor does there appear to be any useful purpose to be served if such a disclosure were arranged.

FOLLOWUP ACTIONS

The present DOE guidelines for radiation exposure are published in Manual Chapter 0524, Standards for Radiation Protection, most recently updated on March 30, 1977. The overall philosophy is for operations to be conducted in a manner to assure that radiation exposure to individuals and population groups is limited to the lowest levels practicable. As applied to the NTS, MC 0524 requires that onsite exposures be limited to 3.0 rem/quarter and 5.0 rem/year and offsite exposures be less than 170 mrem/year for unprotected populations and 500 mrem/year for controlled populations.

Medical followup of radiation exposures incident to nuclear testing has been required since October 4, 1971. In the most recent update of the Nevada Operations Office Manual Chapter 0528, Occupational Medical Program (February 3, 1977), an immediate physical examination, coupled with a medical followup program, is called for when an individual has been subjected to any of the following: (Substantially the same as for 1971.)

- radiation exposure above MC 0524 guidelines
- more than 10% of allowable organ or body burden
- more than 50% of allowable lung burden
- contamination of open wounds
- skin damage or clinical symptoms indicating radiation exposure

Further, a complete termination physical is required when such an individual leaves DOE or DOE contractor employment. At present, there is no requirement for long-term followup after workers terminate.

As a further extension of the policies embodied in MC 0524 and NV/MC 0528, the Department of Energy is offering a medical examination to any present or former employee of AEC/ERDA/DOE or its contractors who has a documented past radiation exposure from nuclear weapons testing above the current guidelines of 5.0 rem/year or 3.0 rem/quarter for radiation workers, and who did not receive medical attention comparable to that now provided to NTS workers.

From the information which Dr. Caldwell and others have furnished this Committee, it appears that there may be a need for an independent investigation of the disease histories among those present at nuclear tests. As I indicated in my earlier testimony of January 26, DOE is planning to support, in conjunction with DOD and the VA, an independent investigation conducted by the National Academy of Sciences. At the same time, we believe that it is desirable that the work of Dr. Caldwell be continued in parallel with whatever work is done by the Academy. We feel very strongly that such studies should be conducted and managed outside of the programmatic concerns of DOE and DOD. To assist such studies, we are publishing this week in the Federal Register a proposed revision to our Privacy Act System "ERDA-30" to provide for additional routine uses of the exposure record information in that system. This revision would permit disclosure of certain specific personnel dosimetry information for study purposes to the Department of Defense, the Center for Disease Control and the National Academy of Science. This should facilitate the followup epidemiological work concerning personnel exposures on Event SMOKY and on other events where meaningful exposure information may exist.

Mr. Chairman, this completes my prepared statement which I will submit for the record, along with detailed material to answer some of your previous questions. As indicated in my February 8, 1978, letter to you, we expect to complete our responses to your questions requiring an extensive review of our radiation exposure and health records by about March 29, 1978, and will then submit that material for the record.

I will be happy to try and answer any questions the Committee may have.

DOE RESPONSES TO QUESTIONS FROM THE SUBCOMMITTEE ON HEALTH AND THE ENVIRONMENT

B-1.	Addressed at January 26, 1978 hearing (see question A-1)
B-2.	Response attached
B-3.	Response attached
B-4.	Response attached
B-5.	Response to be provided at February 14 hearing
B-6.	Response attached
B-7.	Response to be provided at February 14 hearing
B-8.	Information will be provided by March 29, 1978
B-9.	Response attached
B-10.	Information provided in attached responses to questions A-8. and A-10.
B-11.	Partial answer to be provided at February 14 hearing, further information by March 29
B-12.	Response attached
B-13.	Response to be provided at February 14, 1978 hearing, if not covered by February 8 DOE testimony
B-14.	Response attached
B-15.	Dr. Auxier will respond through DOE by about March 29, 1978

Topic B-2

Q How many individuals -- military and civilian — were involved in the test program, as program employees, participants, or observers?

A The personnel breakdown for the 1945-1961 test series was estimated based on the number of film badges processed for the continental and Pacific testing programs. For on-continent testing, only personnel under the cognizance of the onsite test organization were film badged by the AEC. However, a review of all nuclear weapons test-related documents at the Nevada Operations Office produced a detailed personnel breakdown for the Desert Rock exercises 5, 6, 7, and 8.

The personnel breakdown for the 1961-1976 test series was also based on the number of film badges processed but also includes the military, civilian, and visitor categories. It is important to note that the attached tabulated values incorporate such error as round-off and multiple badging.

PERSONNEL PARTICIATION IN WEAPONS TESTING (NOTE 1)
ESTIMATES FROM NUMBER OF PERSONS FILM BADGED
(INCLUDES MULTIPLE BADGING AND ROUND-OFF)

YEAR	CONTINENTAL	DESERT ROCK	PACIFIC
1945	800		0
1946	150		11,500
1947	25		0
1948	0		1,500
1949	0		0
1950	0		0
1951	6,000		3,600
1952	2,800		2,300
1953	3,900	17,557 Military 139 Civilian (Note 2)	900
1954	265		12,700
1955	4,100	8,185 Military (Note 3)	2,900
1956	900		20,500
1957	29,500	10,876 Military 56 Civilian (Note 4)	1,100
1958	8,600		27,500
1959	7,100		500
1960	-no data-		50
1961			0
1962			25,600 (0 in Pacific after 1962)

Notes:

[1] Personnal Consultation with Bob Fredericks (REECo)

[2] Operation Summary, UPSHOT/KNOTHOLE 1953, (P. 92)

[3] Exercise Desert Rock VI, Final Report of Operations, AG 4496, 1955

[4] Exercise Desert Rock VII & VIII, Final Report of Operations, 1957, (P. 91, Annex E)

Topic B-2

PERSONNEL PARTICIPATION IN WEAPONS TESTING (NOTE 1)
BASED ON NUMBER OF FILM BADGES FROM NTS

YEAR	MILITARY	CIVILIAN	VISITORS
1961	1,249	10,806[2]	
1962	4,890	35,656[2]	
1963	230	24,359[2]	
1964	1,590	31,190[2]	
1965	1,135	32,248[2]	
1966	828	40,584[2]	
1967	1,357	38,646[2]	
1968	1,195	40,677[2]	
1969	662	35,865[2]	
1970	661	11,371	16,433
1971	609	12,295	16,576
1972	498	11,600	9,385
1973	4,352	8,401	10,812
1974	380[3]	10,413	8,354
1975	1[3]	11,915	7,873
1976	1,284[3]	12,060	3,483

Notes:

[1] Form 190--Personnel Exposures

[2] Civilian pertains to all nonmilitary--no further breakdown.

[3] Military includes persons working under military contract not necessarily part of military organization.

Topic B-3

Q Describe the nature and extent of these individuals' (those involved in the testing program) involvement in the nuclear test program.

A For the Pacific test operations in the 1940's, civilian personnel assembled and tested the nuclear devices and built and operated scientific diagnostic equipment in conjunction with device tests. However, for those early operations, most other functions were furnished by the military.

A large part of the scientific experimentation during these tests was to determine weapons effects; all of these experiments were undertaken by military personnel and military contract personnel, functioning within the scientific task group. In addition, military personnel in overseas operations manned and maintained the ships and aircraft, provided security, provided administrative and logistics support, and built and assembled test structures and gear related to the test events. Also, they provided a variety of support personnel such as technical photographers, radiation safety monitors, some boat operators, and SCUBA divers. During Operations Crossroads and Sandstone, the military task groups provided all housing (aboard ships mainly) and feeding. During later operations, they provided some housing and feeding aboard military ships and at Enewetak Atoll on Enewetak Island only. Many military personnel were only observers from the ships, aircraft, or remote islands where they were located.

The extent of involvement in operations involving radioactivity varied greatly among participants. The air crews of the sampling aircraft (including both military and civilians) which penetrated the radioactive clouds shortly after the explosions had a probability of higher than usual exposure; the test participants and the accompanying monitors who reentered the shot and nearby islands shortly after the explosions to recover scientific data and gear were subject to radiation exposure and to possible contamination by local fallout; boat operators and light aircraft crews delivering people and equipment to the contaminated islands were subject to light radioactive "shine" and to a small degree to contamination brought to their craft by others; generally their exposures were well below guidelines. All others (employees, participants, or observers) were not normally exposed to radiation. However, in 1954 on the Castle "Bravo" event, fallout fell on the fleet carrying regular crews and other military and civilian test personnel. Later, after the Redwing "Tewa" event, fallout landed on the headquarters islands Elmer and Fred at Enewetak and on the Fleet anchored in the Enewetak lagoon—both caused a large number of people to be exposed to moderate doses of radiation. In addition, some visits to radiologically contaminated ("hot") areas were made by a relatively few observers and cameramen to assess and to record damage to structures and equipment.

Between the early Operations Crossroads and Sandstone, military personnel entered the "hot" areas to clean them up and to build roads, bunkers, structures, and facilities for the next upcoming test series.

As mentioned above, nonmilitary personnel in the 1940's were few compared to military. They were generally scientific and technical participants or official observers, and they were subject to the same exposure probabilities as for military test participants, radiation monitors, and observers as outlined above.

Starting before the Greenhouse Operation, a contract was awarded to Holmes & Narver, Inc. (H&N) to provide for support and construction for the Enewetak tests. From that time on H&N provided all housekeeping, support, and construction at Enewetak, Bikini, Johnston Island, Christmas Island, and off-islands for the tests through 1962. Thus H&N personnel were continuously present at the Pacific Proving Ground during the 1950's and at Christmas and Johnston Islands in 1961 and 1962. Their people operated interisland work and passenger boat transportation, all vehicles and heavy equipment, all "up-island" camps, and all of the heavy construction equipment. They were subject to low-level radiation from previous tests during interim periods between operations and to higher levels during operational periods during equipment and data recoveries and in construction and support of operations on "hot" islands.

Civilian and military members of the scientific task groups were also subject to relatively high levels of radiation when working in "hot" areas and to lower levels while preparing experiments. Many were housed in "up-island" camps where there were elevated background levels from previous tests. Because their accumulated radiation doses often approached the maximum permissible for the operation, many scientific and contractor personnel were forbidden to go into "hot" areas. The effect of this was that nearly all of the persons in the scientific task groups sooner or later made recovery trips to "hot" locations and consequently most of them received near maximum permissible doses of radiation with some in excess. The same is true of many of the contractor craft-support personnel.

When atomic testing began in 1951 in Nevada, construction was performed by the R. E. McKee Co., and the scientific group was a mixed group of civilians from the AEC, Los Alamos Scientific Laboratory, the Sandia Laboratories, and military personnel performing scientific and staff support. Among this group, all but the staff personnel were subject to exposure to radiation during setup and recovery of scientific experiments.

The military provided air crews for drop and sampling aircraft; meteorological and forecasting personnel; a company of soldiers with vehicles for emergency evacuation of persons offsite who may have been in a fallout area; support at Indian Springs AFT for housing and messing, vehicles, and some supply, plus Chemical Corps and Corps of Engineer personnel for participation on rad-safe teams and special projects.

Of these persons, the sampling plane air crews were certain to have been exposed to radiation, and the aircraft decontamination crews at Indian Springs AFT were subject also to exposure and contamination. The engineers who acted as part of the rad-safe organization were also exposed to radiation. The other military personnel in the so-called "onsite" organization were not exposed.

In addition, numerous official observers from Congress, Federal Civil Defense Agency, DOD, AEC, and the laboratories watched the events of Ranger from the control point some eight miles south of the drop target. None of these observers would have been exposed to radiation.

Following Operation Ranger, the Nevada Test Site became a semipermanent facility. Contractor support for feeding, housing, and maintenance and for construction and craft support of experimenters was thereafter provided by the AEC. The experimenters and construction and support people were exposed to radiation in the same manner as at the Pacific Proving Ground. In addition, in the 1950's, the Federal Civil Defense Administration (FCDA), as well as the Laboratories, the DOD, and the AEC contractors, conducted numerous effects experiments which required them also to enter radioactively contaminated areas. The number of experimenters and observers generally was considerably larger in Nevada than in the Pacific. Many FCDA civilian observers entered contaminated areas relatively soon after some events.

The military during the 1950's conducted a number of so-called Desert Rock exercises during which troops observed events from a variety of positions close in and further out from the ground zeros. Their operations plans were coordinated with the AEC to assure that interference with the objectives of the AEC test operations was avoided.

Besides the drop and sampling air crews exposed on every atmospheric event, the military flew many training missions with a variety of aircraft from both U.S. and National Guard units. The Nevada Test Organization maintained air control of all participating aircraft in the closed airspace above the NTS. However, the military planned and executed their own air operations.

Topic B-4

Q Can you detail the extent of these employee's, participants', and observers' radiation exposures?

a. Is their total ionizing radiation exposure known?

A For years prior to 1957 on the U.S. continent and for most* Pacific operations, the whole-body penetrating radiation dose received by participants who wore film badges is known. It is believed that not all personnel who may have been exposed wore film badges during these period; to the extent that that may be so, some possible exposures may not be known.

Generally, the whole-body penetrating photon radiation dose received by all NTS personnel who had NTS security badges is known for the period including 1957 to the present. Form 190 reports are available in the DOE/NV files for the years 1958 through 1977 at NTS. The Form 190 reports summarize the numbers of personnel badged per years, and the numbers exposed within increasing accumulated dose intervals for each year.

Dose to personnel from internally deposited radionuclides during atmospheric testing generally was not appreciable relative to external exposure. The clouds from high yield detonations typically rose to 40,000 feet and were diluted by mixing with air. Radioactive particles in early fallout near the test location were large and generally above the respirable particle size range. Nasal swabs taken at NTS during 1957 from rad-safe monitors and others in the test areas during early fallout and soon after detonation consistently indicated no inhalation of resuspended radioactive material. Thus, internal doses do not appear in our records for atmospheric testing periods. Urine analysis was done for selected personnel who worked with resuspendable radionuclides, and negative results verified that respiratory protection and anticontamination procedures used were effective.

When underground testing commenced at NTS, the probability of dose from internally deposited radionuclides increased, and emphasis was placed on analysis of body fluids and direct measurement of radioactivity in body organs. Measurements of whole-body doses from internally deposited tritium appear in NTS records beginning in 1958, the year after the first underground test in a tunnel. The first thyroid dose measurements appear in the NTS records in 1962. Thus, as appreciable dose from internally deposited radionuclides became probable with the introduction of underground testing, techniques were employed to monitor internal doses, and these dose measurements appear in the NTS records.

Q b. Do their radiation exposure records include a measurement or estimate of alpha, beta, and neutron exposure?

A Alpha particle radiation from external sources is stopped by a few inches of air or the dead layer of the skin, and personnel do not receive dose from alpha-emitting radionuclides unless the radioactive material is deposited internally. As discussed above, personnel who worked with resuspendable radionuclides, including alpha emitters, wore protective clothing and respirator equipment. Nasal swabs and urine samples from these personnel have indicated no reportable internal deposition of alpha emitters.

Skin doses from external sources of beta radiation are in the records for some Pacific and NTS exposure periods. Beta dose to the skin can result in skin burns at very large doses of several hundred rem, and there have been a few reported cases of beta burns to the hands that were not fully recorded by a film badge worn on the chest. However, skin burns are a short-term effect of much less biological significance than whole-body penetrating radiation exposure of the red bone marrow. Thus, less emphasis was placed on monitoring doses to external beta radiation than on monitoring penetrating radiation doses.

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*No dosimetry records are held for Operation Wigwam.

Beta radiation of high enough energy can penetrate to and expose the lens of the eye. Dose to the lens of the eye was not monitored during atmospheric testing periods.

Most of the dose to the thyroid from internally deposited radioiodines is from beta particles. As discussed above, internally deposited radionuclides, including beta emitters, have been monitored by urine analysis and direct measurement of body organ radioactivity, and any assigned doses from such analyses are in the NTS records.

Only personnel who worked with neutron sources were monitored for neutron doses. The records list some personnel monitored for neutron exposure at NTS beginning in 1957 to the present.

Q c. Do their radiation exposure records include a measurement or estimate of ingested or breathed long-lived or short-lived internal emitters?

A As discussed above, personnel were monitored for internal exposures by urine analysis and direct measurement of radioactivity in body organs at NTS when appreciable internal deposition was suspected. Internal exposures to tritium and radioiodines appear in the records for NTS beginning in 1958.

Q d. Are internal emitters a source of radiation exposure which could result in increased incidence of disease?

A Internal emitters are a source of radiation exposure which could result in increased incidence of disease. However, inasmuch as the personnel measurements of test participants did not indicate internal emitter depositions, no increase in radiation exposure is indicated.

Topic B-5

Q Please describe the radiation safety program during the nuclear test blast program.

A The basic radiological safety program used in both the Pacific test series and the Nevada operations (other than with Desert Rock Exercise participants) consisted of three main elements: monitoring, dosimetry, and radiological support.

The primary purpose of the monitoring program was to determine the location and intensity of the radiation field that was created by the nuclear explosive detonation. This was done by initial survey teams, equipped with radiation detection instruments, who entered and, to some extent, marked the test area shortly after the detonation. The time of entry varied from a few minutes to several hours. These survey teams used radio-equipped vehicles or helicopters and determined the radiological situation using portable radiation detection instruments. Maps were then prepared from this information and dose rate contours plotted. This dose rate information was then used in briefing reentry and recovery parties and determining the time at which those parties could enter the contaminated area and how long they could remain in the area.

The dosimetry program was set up to measure and keep track of the radiation exposures of test participants. The primary radiation dosage measuring device used was the film badge; pocket dosimeters were routinely worn by reentry personnel but they were used primarily to determine promptness with which the film badge was processed. That is, if the pocket dosimeter indicated a significant dosage received by the individual, such as 500 mR or above, the film badge worn by the individual was usually processed and read immediately rather than waiting until later in the day. Each film badge had an identifying number embossed on the film, and records were maintained of individuals issued each film badge. When the film badge records indicated that an individual was approaching, or had exceeded, the permissible exposure limit, that individual was no longer allowed to enter a radiation area. A determined effort was made to follow the exposure records closely to prevent anyone from exceeding the permissible exposure limit.

Controlling access to the radiation areas was a function of the support program. The personnel working in the support program briefed the groups that were planning on reentering the controlled area, advising as to the radiological situation and the length of time the party could remain in the area using information obtained from the dosimetry records. In addition, a determination was made that the reentry party had a qualified monitor assigned to accompany the party into the controlled area and advise the party leader as to the current radiological situation while in the area. Further, this support group would issue the proper protective gear, such as clothing and booties, and respirators if required, to the reentry parties. The party could then proceed to the reentry control point where they were checked for compliance with the radiological safety requirements and were then allowed to enter the radiation area.

The radiological safety support program provided for briefings and training. The briefings, for basic indoctrination, were required for all participants and were primarily nontechnical instruction in radiological safety measures and techniques. Technical training was given to the personnel who staffed the radiological safety organization and to those people designated as party monitors.

Prior to 1955, records and reports indicate that film badges were not issued to all task force personnel. Instead, they apparently were issued to those people who would be expected to enter and work in a radiation area. The 1954 Operation CASTLE Test Manager's Report states, "Prior to shot day, Eniwetok [sic] Atoll and the Task Force fleet will be covered by a representative number of film badges in order that an average dose may be assigned each individual in the event of fallout."

The 1955 Operation TEAPOT Onsite Rad Safe Report indicates the policy of badging all NTS participating personnel was started with the TEAPOT test series. Subsequently, all NTS test participants except Desert Rock troops on exercise were badged by the AEC system. Film badges were issued to each individual participating in the Pacific test operations starting in 1956. During the 1957 Operation PLUMBBOB, every person entering the NTS was issued an NTS film badge except for Desert Rock troops on exercises and official observers outside the controlled areas. Since 1957, the policy of issuing a film badge to each individual entering the NTS has continued.

In some cases (for example the Navy Task Group (in the Pacific) and the USAF support flying out of Indian Springs AFB near the NTS), the film badges were issued in bulk to the participating organizations, who in turn issued the badges to the individuals. The film badges were exchanged periodically and returned to the central dosimetry facility for processing and for entry of radiation dose information into exposure records.

Topic B-6

Q: a. What forms of radiation are not measured by the badge?

A: The various types of film badges used during nuclear detonation tests always were used to measure whole-body penetrating photon radiation dose from gamma and x-rays. A metallic filter was used over portions of the film to determine photon radiation dose. Sometimes, measurements of film optical density in areas not covered by the metallic filters were used to determine nonpenetrating radiation dose from beta radiation and low energy photons. The current NTS film badge used since 1965 also measures dose from thermal neutrons. Additional film packets in use at NTS for selected personnel since 1957 are used to monitor dose from fast neutrons by nuclear track counting. Forms of radiation not usually measured with film packets include alpha particle radiation and intermediate energy neutrons. Also, film packets are not used to measure dose to body organs from internally deposited radionuclides.

Q: b. How accurate are the badges in measuring radiation? How suitable?

A: Film badge accuracy varies with the amount of radiation dose and the environmental conditions during radiation exposure and before processing. Accuracy is least at the lowest exposures measured, and increases with increasing dose. Under laboratory conditions, accuracies of ±50% at 30 mrem, ±20% at a few hundred mrem, and ±10% above 1 rem routinely are attained for gamma radiation. These accuracies decrease to about ±60%, ±30%, and ±15%, respectively, under field conditions.

However, such inaccuracies usually appear on the conservative side. That is, environmental effects on film usually cause the film dosimeter to indicate a higher dose than received by the wearer. An important exception is high humidity which may cause radiation induced film darkening to fade or may damage the film beyond use. Fading and damage can be avoided by using moisture-proof containers as was usually done during Pacific operations. High humidity conditions are not a problem at NTS.

Film badges are suitable for monitoring whole-body penetrating photon radiation doses which are the most important doses from external sources after a nuclear detonation regarding adverse biological effects.

Q: c. How reliable was the method of processing the badges and reading their exposures?

A: The procedures for processing film badges, measuring net optical film emulsion densities, and assigning doses from calibration data have changed little from 1945 to the present. The technology had been developed in the 1930's for measuring radiation dose with films. Provided that films are developed under temperature-controlled conditions, optical densities are measured with a good-quality densitometer, and calibration data are traced through an NBS-calibrated R-meter, than the results of dose determinations with film dosimeters are acceptably reliable. Procedures used for both Pacific and U.S. continent testing operations were as above.

Q: d. Is it true the badges were designed and processed as an indicator of low-level ionizing radiation? What effect would there be on such a badge which received a much higher exposure?

A: The minimum reportable photon radiation dose recorded from film badge processing was either 20 or 30 mR during nuclear weapons testing. These amounts are "low-level" doses compared to the usual exposure guides of 3000 to 5000 mR for quarterly, operational, or yearly exposure periods.

Each film packet used contained either two or three individual films, and each film was used for a different exposure range. A typical two-component film packet measured photon dose of 30 to 5000 mR on the low-range film and 4000 mR to 800,000 mR (800 R), or more, on the high-range film. Thus, if an exposure exceeded 5000 mR on the low-range film, the exposure could be determined from the high-range film. Exposures did not exceed the high range because personnel receiving such doses in the 100% lethal range would have most certainly become incapacitated within a relatively short time period.

If the above film packet was exposed to several hundred R, then the low-range film might undergo a change known as "solarization," or, more commonly, "reversal." When reversal occurs, the net optical density of the developed film emulsion decreases with increasing dose. However, the high-range film could not reverse unless it was exposed to many thousands of R, a dose range which certainly would be lethal to the wearer after a short time period. Low-range films which reverse after exposure to nuclear radiation continue to exhibit density equivalent to about half of their ranges - about 2000 mR for the above typical film packet. Complete reversal is not attained unless the film is removed from the packet before development and exposed to light.

Q: e. Would such a badge reflect that much higher exposure if routinely processed as if it received a low-level exposure?

A: It was routine procedure during all atmospheric nuclear testing operations either to develop both the low-range and high-range films or to develop the high-range film if the low-range film indicated a dose of 1000 mR or more. This assured that any reversed low-range films would be detected, and the high-range film or films could be used to assign doses. The use of high-range films to verify dose assignments when low-range films were damaged is shown in our records as early as 1945 during the Trinity operation.

Q: f. In the badging program, what percentage of the badges were lost, destroyed, damaged, improperly developed, defective, or otherwise left in a state of questionable validity?

A: We have no means of determining the requested percentage accurately for all past testing years. Several groups of films from past testing operations have been damaged, destroyed, or lost during storage in archives. Determination of these percentages from all existing films and records would be a massive clerical task requiring a long time period and considerable funds. The statement can be made that some film packets were not returned for processing by the wearers. The percentage of nonreturned film packets generally is small for scientific personnel and radiation workers. A study done last year indicated that 1.25% of all film packets issued at NTS in 1976 were not returned for processing. Also, the percentage of destroyed, damaged, improperly developed, or defective film packets generally is small. The percentage of unassigned doses in these cases is reduced to near zero. Damaged film evaluations techniques, dose rate and dose time information, self-reading pocket dosimeter readings, and doses received by accompanying workers allow evaluation and assignments of doses. It was determined that the percentage of returned film packets damaged by all causes in October and November, 1977, was between 0.7 and 0.8%. Doses were evaluated and assigned in every case.

Q: g. Was the radiation monitoring program the same over the years (1946 to present)? Or did it change from earlier to later years?

A: The basic principles of the radiation monitoring program have remained about the same. Changes in application of these principles have resulted from different emplacement techniques for tested devices and from increasing technical capability regarding radiation measurement instrumentation.

During atmospheric detonations, radioactive debris was monitored primarily by aircraft and ground survey teams using portable radiation detection instruments. When testing underground began, remote area monitoring equipment was developed to initially telemeter measurements to a central control point outside the test area.

Similarly, when monitoring low-altitude radioactive effluent clouds from underground tests became necessary, emphasis was placed on sampling effluent for analysis of specific radionuclides which no longer constituted a predictable gross fission product mixture as was the case during atmospheric testing. Also, more emphasis was placed on monitoring individuals through organ counting and urine analysis after underground tests began because conditions no longer existed where there was dilution or gross fission products by mixing at high altitudes as after atmospheric tests.

However, monitoring of personnel exposures to whole-body penetrating photon radiations remained about the same with some increased capability to monitor nonpenetrating radiations.

Q: h. Was the radiation monitoring program in the Pacific different from that in Nevada?

A: The principles and objectives were the same in the two areas. Differences in techniques included the use of small boats as required for transportation to islands in the Pacific, and more use of helicopters for initial radiation surveys in the Pacific. Other monitoring and dosimetry techniques were essentially the same except, beginning in 1961, when remote area monitoring with telemetered radiation measurements was instituted at NTS.

Topic B-7

Q: Describe the normal decontamination procedures for those individuals exposed to excessive levels of radiation.

A: This question tends to unnecessarily confuse radiation exposures with personnel contamination. In preparing responses, it is our interpretation that the entire question dealt with contamination. Any contamination of personnel was considered unacceptable.

Q: a. What did AEC consider to be an excessive level of radiation (sic)?

A: The rule was, and still is, to decontaminate an individual until the measured dose rate on every part of the body is less than the permissible level, using all reasonable means. (Examples of permissible personnel contamination levels are enclosed.) This rule applied regardless of the source of the contamination, e.g. caught in fallout, or picking up contamination while working in the contaminated area of a nuclear test, or a radex (radiological exclusion) area.

Q: b. Under what circumstances were people monitored to determine whether they had excessive radiation exposures?

A: Personnel leaving a radex area or caught in fallout were monitored with suitable instruments to detect contamination.

Q: c. What decontamination measures were followed for excessive exposures?

A: If contamination was found on the outer clothing, all outer clothing was removed. Then the under clothing and the exposed parts of the body were monitored. If the permissible level still was exceeded, the remainder of the clothing was removed and the individual was made to shower thoroughly. After showering, the individual was monitored once again. If he were still contaminated in excess of the permissible levels, he reshowered using a suitable scrub brush, taking care not to abraid or severely irritate the skin. This procedure was repeated if necessary. These procedures were usually sufficient to remove all contamination from the body. On rare occasions, a beard, or the hair on the head had to be shaved off to get the individual below the permissible levels.

Q: d. Were the decontamination procedures in Nevada different from those in the Pacific Testing Program?

A: Decontamination procedures in Nevada were essentially the same as in the Pacific regarding contaminated personnel exiting controlled radiation areas. Any anticontamination clothing and respiratory protective equipment worn by personnel was removed carefully and placed in provided radioactive material containers. Personnel then were monitored with portable radiation detection instruments.

Personnel with contamination on the skin or hair were showered and remonitored to assure effectiveness of decontamination. Nasal swabs were taken and monitored if inhalation of radioactive materials was suspected. Urine samples also were collected and analyzed in some cases to detect internal deposition. Direct measurements of radioactivity in body organs was instituted at NTS after commencement of underground testing at NTS increased the probability of appreciable internal depositions.

EXAMPLES OF PERMISSIBLE LEVELS OF CONTAMINATION ON PERSONNEL FOR WEAPONS TESTING PROGRAM

Nevada Test Site (NTS)

1957 (Earliest record found)

Reference: Radiological Safety Handbood for the Nevada Test Site 1957 (RRS-57-3)

"Permissible Levels of Contamination

The maximum permissible surface contamination levels at the Nevada Test Site are as follows:

"(b) Personal and Underclothing

1 mr/hr	gamma
100 c/m/55m^2	alpha

(c) Protective clothing, outer clothing and shoes.

7 mr/hr	beta and gamma
500 c/m/55cm^2	alpha"

1958

Reference: Basic Radiological Safety Training Manual, REECo, RSD November 1958

"12.6.2 The NTSO-SOP specifies maximum permissible surface contamination levels for Weapons testing and Reactor Source Sources at Jackass Flats as outlined in the following sections.

12.6.3 Radiation contamination levels from Weapons Testing are listed as follows in the NTO-SOP:

b) Personal contamination should be maintained as low as possible and decontamination exercised when levels exceed those shown:

Item	Alpha c/m/55cm^2	Beta & Gamma mr/hr
Outer clothing	500	7
Shoes	500	
Skin or underclothing	100	

Respiratory protective devices, will be maintained at a contamination level less than 1 mr/hr (beta gamma) or 100 c/m/55m^2 (alpha fixed or removable)."

1969

Reference: Standard Operating Procedures of the Radiological Sciences Department, REECo, ESD; Section 18, 1 August 1969

"Decontamination in the Field"

"Maximum permissible contamination levels for release from R/S control are as follows: Beta and gamma measurements are made with an open window probe type G. M. survey meter:

(a) Skin and underclothing: 0.1 mR/hr or 300 cpm

(b) Personal clothing: 0.3 mR/hr beta plus gamma or 900 cpm

(c) No detectable alpha contamination is permissible on either skin or clothing."

1977

Reference: Standard Operating Procedures of the Radiological Sciences Department, REECo ESD; Section 18, Decontamination, January 1977

"18.3.3 Decontamination in the Field"

"8. Maximum permissible contamination levels for release from E/S control are as follows: Beta and gamma measurements are made with an open window probe type G. M. Survey meter:

(a) Skin and underclothing: 0.1 mR/hr or 300 cpm

(b) Personal clothing: 0.2 mR/hr beta plus gamma

(c) No detectable alpha contamination is permissible on either skin or clothing."

Topic B-8

Q: a. How many people suffered excessive radiation exposures in the Nevada testing program and in the Pacific testing program by year (1946 to present)?

A: In addressing this series of questions the Committee asked on this subject, it seems desirable to comment briefly about the term "overexposure." In the case of occupational long-term exposure to ionizing radiation, a person may receive in a single specific time interval doses larger than the pertinent maximum permissible doses. In a literal sense, it may be said that the individual was "overexposed" in that period. However, in reality, the connotation of injury does not apply to such an exposure unless the doses were very much larger than the pertinent maximum permissible dose. Accordingly, a distinction should be made between "technical overexposure" and "overexposure" in the usual sense. While exposures to ionizing radiation at levels above the applicable guidelines are overexposures in the technical sense, that is not a connotation of possible injury. The NCRP stated in the National Bureau of Standards Handbook 59 of September 24, 1954, at page 69:

> "Accidental or emergency exposure of the whole-body of adults or parts thereof to x-rays with photon energy less than 3 Mev, from external sources, occurring only once in the lifetime of the person, under the conditions and in the respective dosages stated below, shall be assumed to have no effect on the radiation tolerance status of that person."
>
> "(a) Exposure of the whole body--any adult. Total dose measurement in air: up to 25R."

Later the NCRP stated in Report No. 39 issued January 15, 1971, at page 100:

> "(261) Since planned whole-body doses up to 25 rems are reasonably accepted for emergency conditions (see paragraph 259), it follows that accidental doses up to the same magnitude should not cause major concern. At higher levels and especially where the whole body dose reaches 100 rems, medical observation and subsequent actions based primarily on medical opinion are the important aspects."

Since the exposures that exceeded operating guidelines were almost always well below the 25R level, and since no medically discernible manifestations of effects may be anticipated below the 25 R level, there has been no apparent operational justification for conducting medical followup. The DOE response to the questions posed under Topic B-8 must be regarded in this light.

With regard to the above question, DOE is screening its data files to determine the numbers of people who received radiation exposures in excess of the guidelines that were applicable. An answer to this request will be available by about March 29, 1978.

Q: b. Has there been any attempt made to make a medical followup with those overexposed individuals to check their health?

A: Today, all radiation workers within the DOE, as well as radiation workers employed by DOE contractors, are subject to medical surveillance during their employment in radiation work, regardless of the levels of radiation exposure. This policy has been in effect since August 21, 1975. For individuals who have received radiation exposures incident to nuclear testing subsequent to October 4, 1971, there has been medical followup. In the most recent update of the Nevada Operations Office Manual Chapter 0528, Occupational Medical Program (February 3, 1977), an immediate physical examination, coupled with a medical followup program, is called for when an individual has been subjected to any of the following:

- radiation exposure above MC 0524 guidelines
- more than 10% of allowable organ or body burden
- more than 50% of allowable lung burden
- contamination of open wounds
- skin damage or clinical symptoms indicating radiation exposure

Further, a complete termination physical is required when such an individual leaves DOE or DOE contractor employment. At present, there is no requirement for long-term followup after workers terminate.

As a further extension of the policies embodied in MC 0524 and NV/MC 0528, the Department of Energy is offering a medical examination to any present or former AEC/ERDA/DOE or contractor employee who has a documented past radiation exposure from nuclear weapons testing above the current guidelines of 5.0 rem/year or 3.0 rem/quarter for radiation workers, and who did not receive medical attention comparable to that now provided to NTS workers.

Other than exposures of individuals that have been followed on this basis, DOE/ERDA/AEC have not conducted medical followup.

Q: c. Were they ever informed of potential increased risk of cancer or other disease as a result of their overexposure?

A: AEC/ERDA/DOE personnel have been advised of unusual exposure and particularly of exposures that have exceeded guideline levels. They have not been told that their exposures potentially increase a risk of cancer or other disease.

Q: d. Were they given medical examinations at the time of radiation overexposure and periodically thereafter?

A: Any individual working for the DOE or for a DOE contractor who is exposed to a degree described in the answer to Topic B-8b above is medically examined at that time. As a radiation worker, he is under medical surveillance so long as he continues to be employed in that work.

Below is a listing by year (and by test series where applicable) to show numbers of exposures in excess of the exposure guideline of 5 rem.

1946	(Trinity Site)	1
1946	Crossroads	14
1948	(Pacific) Sandstone	7
1951	Ranger (NTS)	3
1951	Greenhouse	307
1952	Tumbler-Snapper (NTS)	9
1952	Ivy	18
1953	Upshot-Knothole (NTS)	61
1954	Castle	1,049
1955	Teapot (NTS)	24
1956	Flintlock	4
1956	Redwing	378
1957	Plumbbob (NTS)	34
1958	Hardtack (NTS)	7
1958	Hardtack	87
1961	Nougat (NTS)	107
1962	Nougat (NTS)	14
1963	(NTS) Dominic	9
1964	(NTS) Whetstone	2
1965	(NTS) Whetstone	21
TOTAL		2,156

Topic B-9

Q: We have received reports that the Smoky blast was a particularly "dirty" blast because of high radiation and fallout. Is this true? If so, why was this the case?

--Is it true that experimental equipment in the vicinity of Smoky ground zero could not be retrieved for several days after the blast because of the high radiation levels? Is it not true that Smoky was one of the only blasts in which experiments could not be retrieved within minutes after the explosion? Why? If so, did not some troops enter the area near ground zero shortly after the blast?

A: Smoky was indeed a "dirty" event. The forecast prior to the Smoky event estimated 1,900 megacuries of local fallout at H+1 hour and the measured and calculated amount was 1,928 megacuries. The next largest amount of fallout during PLUMBOB was 1,040 megacuries for a 17kt device on a 500 foot tower.

During the predetonation operational planning for each event of PLUMBOB, the number of megacuries of local fallout normalized to H+1 hour was estimated. This estimate was greater for events where the fireball was in proximity to the ground, tower, steel, concrete, or other material which may be vaporized and act as condensation nuclei to scavenge the radioactive detonation products. For balloon shots, the estimate was essentailly zero. Smoky was fired on a 700-foot tower; the proximity of the Smoky Hills probably provided additional material to scavenge the radioactivity as fallout. Further, the Smoky cloud top was blown toward the east at about 48 knots while the lower cloud segments moved much more slowly in a south-easterly direction. This shear in the cloud, coupled with the large mass of scavenging material, produced heavy local fallout on the NTS in the vicinity of the Smoky event.

It should be noted that the predominant particle sizes measured on arcs throughout the local fallout pattern were well above the respirable size range until the cloud was more than 30 miles off the NTS. Further, the Smoky device contained no plutonium; the fissile material was all enriched uranium.

A number of experiments on the Smoky event could not be recovered until several days after the event due to the high radiation levels, from local fallout, where the experiments were located. This was in consonance with the radiological safety rules, specifically to keep personnel radiation exposures within acceptable levels. In other words, people were not allowed to enter a radiation area for any purpose unless the time spent in the area was such that the radiation dose received was within acceptable limits. This was not an unusual circumstance. In many instances during the various weapons series the radiation levels due to local fallout and induced activity would preclude immediate (sometime on D day) reentry for either data or equipment recovery. One of the present day advantages of contained underground events is the routine early reentry to recover data and equipment without the delay often caused by a radiation field as occurred during the atmospheric tests.

Questions concerning troop positions and maneuvers are more properly addressed to the Department of Defense. Reports prepared by various groups in the Test Manager's organization give no definitive information on this subject. Interviews have been conducted with some of the current DOE contractor personnel who were AEC Test Manager rad-safe monitors on the Smoky event. These people cannot recall having contact with the maneuvering troops.

Topic B-11:

Q Advise the Committee about BANEBERRY followup situation including the number of persons still employed, what is being done about their medical followup, what is being done about followup for those no longer employed.

Can you describe the BANEBERRY underground test in Nevada (December 1, 1970) and the resultant radiation exposure to workers?

--What has been the incidence of disease and death among those workers?

--Is it true that three of those workers died of leukemia in 1974? What were their external radiation exposures that day? What were their internal exposures? What were their exposures prior to and subsequent to that day?

--Is it only a coincidence that these workers, all in the same work camp, all exposed to fallout from BANEBERRY, have died of leukemia?

A (Testimony presented on February 14, 1978, furnished most of the requested information; however, some additional information now is available.)

Based upon a careful check of all known records, there were 873 individuals present in Area 12 of the NTS during the BANEBERRY incident. Out of these, 305 are still in the same employment as they were in 1970. For the 873 persons who were present, film badge records indicate that 9 individuals received between 0.5 rem and 1.0 rem, 25 received between 0.2 rem and 0.5 rem, and 114 received doses between 0.03 rem and 0.2 rem.

Topic B-12

Q: a. Is it true that after 18 other underground blasts between December 12, 1963, and November 24, 1971, off-site radioactivity was reported? What does this mean?

--Did any radiation exposures to humans result from any of these tests other than Baneberry? If so, please describe and explain. If so, has there been any medical follow-up with these individuals?

Ref: WASH-1183 "Summary Information on Accidental Releases of Radioactivity to the Atmosphere From Underground Nuclear Detonations Designed for Containment," August 5, 1963 - June 30, 1971.

A: During the period August 5, 1963, through June 30, 1971, the AEC has announced the detonation of 220 nuclear tests at the Nevada Test Site, which were designed to be completely contained underground. Of these 220 underground tests, 17 tests (see WASH-1183) inadvertently released sufficient radioactivity to the atmosphere to be detected by ground monitors or ground monitoring equipment off the NTS. Post-shot tunnel ventilation the day after one other test (MINT LEAF, May 5, 1970) resulted in a positive off-site reading. In addition, one other test, the DIAGONAL LINE event of November 24, 1971, is not included in the list of 17. Seepage of low level radioactivity occurred a few hours following detonation and could only be detected by extremely sensitive airborne radiation detection equipment. No radioactivity above normal background levels was detected off-site by ground monitors or ground monitoring equipment.

Of the 17 tests which released sufficient radioactivity to the atmosphere to be detected by ground monitors or ground monitoring equipment off the NTS, only three were of any significance in terms of potential human exposures. These were the PIKE event, March 13, 1964, the PIN STRIPE event, April 25, 1966, and the BANEBERRY event of December 18, 1970. Of these three events, the highest recorded exposure or dose was as follows:

The highest potential external whole-body gamma radiation exposure resulted at Cactus Springs, Nevada, following the PIKE test. The total exposure to an individual at this location was calculated at about 55 millirems. This amount of radiation exposure can be compared with the 100 to 150 milliroentgens average dose humans receive from natural radiation every year. The Federal Radiation Council's guidance for whole-body exposure to an individual in a population is 500 millirems per year.

The highest radioiodine content found in milk where children were living was at the Schofield Dairy near Hiko, Nevada, where a peak level of 4800 picocuries of iodine-131 per liter of milk was recorded following the PIN STRIPE test. Had this milk been consumed, this would result in exposures less than one-tenth of the Protection Action Guide of the Federal Radiation Council. However, in order to minimize exposures, the AEC arranged with the dairy owner to place these milk cows on dry feed for about three weeks. In addition, 90 people residing in this area were examined for radioiodine of the thyroid. Low levels of radioiodine were detected in the thyroid of 19 of the 90 people studied. The projected doses to the thyroid of these 19 people ranged from 50 to 300 millirads (equivalent to millirems). The Federal Radiation Council's guide for exposures of the thyroid is 1,500 millirems per year to an individual in the general population.

Based on all the off-site monitoring data collected following these releases, it is concluded that exposures to the public from these tests did not exceed the Radiation Protection Guides for the general population recommended by the Federal Radiation Council.

No specific medical follow-up of exposed off-site individuals occurred following these releases.

Q: b. Please explain the scope and nature of the 23 nuclear tests conducted in Nevada between September 15, 1961, and August 20, 1963.

--Were any of these 23 tests atmospheric tests?
--Was radioactivity emitted into the atmosphere as a result of any of those 23 tests?
--Has there been any medical follow-up with any of these individuals?

Ref: TID-18892 "Off-Site Environmental Contamination from Nuclear Explosives at the Nevada Test Site." September 15, 1961 - September 15, 1962.

SWRHL-1r "Final Report of Off-Site Surveillance for Operation NOUGAT." September 15, 1961 - June 30, 1962.

SWRHL-3r "Final Report of Off-Site Surveillance for Operation DOMINIC II." July 7, 1962 - July 17, 1962.

SWRHL-4r "Final Report of Off-Site Surveillance for Operation STORAX." July 1, 1962 - June 30, 1963.

SWRHL-32r "Final Report of Off-Site Surveillance for Operation NIBLICK." July 1, 1963 - June 30, 1964.

A: During the period September 15, 1961, through August 20, 1963, there were 98 announced nuclear tests at the NTS of which four were surface detonations, two were cratering and two were Plowshare device development tests. Of the 98 tests, 23 tests were announced by President Kennedy but not specifically named. Of these 23 tests, 17 released small quantities of radioactivity but none were detected off-site. Of the 98 announced tests, the following released sufficient radioactivity to the atmosphere to be detected off-site:

Name	Type	Date
ANTLER	Tunnel	9/15/61
FEATHER	Tunnel	12/22/61
PAMPAS	Shaft	3/01/62
DANNY BOY	Cratering	3/05/62
PLATTE	Tunnel	4/14/62
EEL	Shaft	5/19/62
DES MOINES	Tunnel	6/13/62
SEDAN	Cratering	7/06/62
JOHNNIE BOY	Surface	7/11/62
SMALL BOY	Surface	7/14/62

Little Feller II (7/7/62) and I 7/17/62), although surface tests, were not detectable off-site with any degree of certainty due to the residual activity from the SEDAN and SMALL BOY detonations respectively. No persons were exposed to radiation exceeding guidelines and no follow-up of persons present during the events was done or is contemplated.

Topic B-14

Q a. In what condition are DOE's radiation exposure records for those participating in SMOKY and other nuclear tests in Nevada and in the Pacific.

A Information provided under Topic A-3. describes completeness of DOE/NV records for nuclear tests in the Pacific and in Nevada. The condition of the records varies depending on the particular test operation period. Generally, less identification information is available for early testing operations in both the Pacific and Nevada, and the type of identification information is different during different test operations until standard automated data processing formats were adopted for radiation exposure reports in 1958 in the Pacific and in 1957 in Nevada.

However, regardless of uniformity or completeness of early test operations identification data, all records maintained by REECo in the computer file and automated microfilm file have been organized in a common format. This will allow writing computer programs to segregate records, where identification is possible, of military personnel, personnel within specific organization groups, and within intervals of accumulated exposure amounts for specific time periods and locations.

An important continuing project is the search for additional records which may not now be in the computer file. For example, comparison of computer file records with test operation reports has indicated that some USNRDL dosimetry records for the 1955 Wigwam operation in the Pacific are missing. It is probable that these and other additional radiation exposure records will be located by contacting DOE operations offices and the military services, and instituting a search of files and archives for additional records.

Q b. What will have to be done to these records to make them suitable for use in a followup epidemiological study? How long will that take and what will it cost?

A A dosimetry records project is now in progress which is consistent with making the records suitable for a followup epidemiological study to the extent permitted by available information. The project consists of the following elements:

(1) Retrieve from archives all historical source documents and organize these records in chronological sequence for Pacific and U.S. continent testing years.

(2) Conduct a detailed inventory which describes the available source records.

(3) Compare these radiation exposure records with the existing computer file to assure inclusion of all exposure records in the file.

(4) Identify periods of time where source documents may be missing.

(5) Institute a nationwide search for additional radiation exposure records which may not be in the current file.

(6) Research and compile a report detailing the history of personnel radiation dosimetry for nuclear device testing in the Pacific and on the U.S. Continent.

(7) Analyze and evaluate the computer file information to determine and implement computer programs for segregating records of military and civilian personnel by organizational groups, exposure periods and locations, intervals of accumulated dose, and lifetime accumulated exposures from nuclear testing for individuals.

(8) Coordinate with appropriate DOE, DOD, and epidemiological study personnel the selection of types of computer output information to be made available from the files.

The current project is funded for this fiscal year, and funds have been requested for the next two fiscal years. The level of funding averages $250,000 per year. At this level, it is anticipated that the project may be completed within three years at a total cost of $750,000. However, additional project requirements for conformity with use of records for the epidemiological study may extend the completion date at the current level of effort.

Q c. Does DOE have the personnel and money available to prepare these records for such use? Will these personnel and monies be made available? When? Are these dollars and personnel provided for in the newly proposed 79 budget?

A Under the funding for this fiscal year, the following REECo personnel have been committed to this effort:

(1) One Senior Clerk and one Clerk Typist are now performing Tasks (1), (2), and (3) detailed in b. above.

(2) One Personnel Dosimetry Supervisor is spending part time on this project.

(3) One Computer Programmer will spend part of his time on Task (7) above.

(4) One Oral Historian is being hired to devote full time to Task (6) above, and one Word Processing Operator will devote part time to Task (6) and other tasks as needed.

(5) One Senior Health Physicist experienced and knowledgeable regarding past nuclear testing operations is now devoting full time to Tasks (4), (5), and (8) in addition to training, assisting, and coordinating the work of the personnel above.

Topic B-15

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
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NUCLEAR DIVISION

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February 21, 1978

Dr. Walter H. Weyzen
Division of Biomedical and Environmental Research
U. S. Department of Energy
Washington, D. C. 20545

Dear Walt:

The following information is in response to your questions contained in the teletype message of February 13:

(1) The Smoky shot was one of the many in which we participated as a part of the Ichiban program. Because of our use of SS materials in the neutron detectors, we had special permission on all blasts to leave the approach barracades at H + 2-5 minutes depending upon the telemetering requirements associated with the diagnostics for the particular weapon. A typical release time for our recovery teams was 3-4 minutes after detonation which we observed, in general, from a distance of from 7-12 miles depending upon the shot location and yield. In this instance the restraining barracades were of the order of 12 miles from ground zero. Our usual routine was for approximately four teams of two persons each to enter the ground zero area as rapidly as possible after detonation to recover the neutron detectors located on either "goal-post" stations, inside water collimator tanks, or on steel cables. In this event, we had detectors on lines of goal-posts running east and north, and on a cable extending to 2,000 yards south of ground zero. P. N. Hensley and I, on the Smoky shot, led the convoy in a military, six-wheel drive, 2-1/2 ton truck. Mr. Hensley was driving and I monitored the radiation levels on the way to the bomb site, using AN-PDR-35 instruments having a maximum dose-rate range of 50 r/hr. As we passed the B-J Y, we began to detect fallout. As we proceeded toward area 2, fallout increased rapidly so that by the time we were approximately five miles from ground zero and before we left the paved road, the fallout levels were rapidly approaching 50 r/hr. I signaled to Mr. Hensley to turn around, adding the hand signal to oral instructions because the full-face assault masks we wore hindered verbal communications somewhat. He immediately made a U-turn to the left and the convoy followed suit, and we went back to the "hot-line" where we removed our anti-contamination clothing, were checked for contamination, left our vehicles for decontamination, and returned to our laboratory area in clean relay vehicles. It was the only time in our long weapons-test experience where we did not recover our detectors immediately; in fact, it was three days before we could complete recovery.

The fallout was indeed the greatest of any we witnessed on the test site; for other detonations the combination of close-in fallout and neutron activation of elements in the soil produced a maximum reading at ground zero of the order of 50-100r/hr. Due to the short-lived activation products near ground zero, the dose reading would normally have decreased to less than 50r/hr. during the first hour after the blast.

Two factors that I can recall led to the high local fallout levels from Smoky: (a) There were more than thirty-five tons of iron, two and one half tons of paraffin, and thirty tons of lead in the tower cab in which the shot detonated. This mass of material would naturally increase the condensation nuclei for early fallout and increase the activation products. (b) The weather on the morning of the shot was extraordinarily bad from a local fallout point of view. The winds from the surface to above the top of the mesas were calm and reached only ten miles per hour at 10,000 feet MSL. Further, the winds aloft were relatively low, being seven miles per hour at 12,000 feet, nine miles per hour at 15,000 feet and increasing at the maximum bomb cloud height to approximately thirty-seven miles per hour. Because of the lack of surface winds at low altitude, bomb residue was not deposited on the usual long track, but settled in the Yucca basin area. I have been unable to obtain the H + 1 hour fallout contours or parts thereof, but I imagine that the summation of "acres times dose rate" was probably the highest of any shot ever fired in the desert. In the direction of the lowest dose rates, the gamma radiation field at 1.6 miles was of the order of 6 r/hr. at H + 1 hour.

(2) Solarization refers to the reversal in optical density (blackening) of film when it is grossly over-exposed, i.e., to much above the limit of its useful range. In general, the optical density increases monotonically with increasing radiation to some maximum value at which the density is almost constant with increasing exposure to "dose" of approximately ten times the exposure which produced the maximum density. Boyond this level, continued exposure decreases or "bleaches" the film so that at doses of the order of 100 times its usual range, it will record lower optical values, i.e., low doses.

In the case of the military personnel engaged in Smoky, I have been unable to obtain with certainty the type of film used, but I have been told informally by two different DOD groups that they are reasonably sure that Dupont type 552 film packages were used. If so, the most sensitive film in the film package was Dupont type 502. This film would reach its maximum density in the exposure range of 3-5r depending upon the techniques used in the particular laboratory. For this film to have been solarized to the extent that the average exposure would have been recorded as less than 1r, it would have taken of the order of 1,000r. This dose, even protracted over a period of 2½ hours, would have caused widespread nausea, vomiting, etc., and would have resulted in a large number of casualties within forty days. Further, the second film in the package, being less sensitive, would have been "black," obvious to the naked eye, and would not have been affected by solarization until the doses were enormous indeed. In conclusion, I must rule out solarization as an explanation of the high instances of leukemia if, indeed, the film packages were appropriately processed, as I must assume that they were.

Of course if the incidence rate for leukemia is truly 4-6 times the normal rate or higher, we know that the exposures were much higher than were recorded by the film. On the basis of our latest and best analysis of the Nagasaki data, the increased incidence rate corresponds to an exposure of the order of 100±50 rads to the bone marrow.

As you are aware, our recent work, spearheaded by Jones and based on the Katz model for cell killing, now shows a beautifully linear relationship between each type of leukemia, chronic and acute, and other cancers with cell killing of the bone marrow. Katz's model is used in order to take into account the different LET of the radiations from the Nagasaki and the Hiroshima weapons. In the event that you have not seen a copy of the paper which has been submitted to RADIATION RESEARCH, I am attaching copies of the cell killing versus leukemia and cancer curves for your information. In addition, I am including a copy of the paper so that you will have everything necessary to interpret the background for these curves. There is still a great deal of work to be done in the further evaluation of the data from Hiroshima and Nagasaki, but as you know we are at the moment without resources to do it, except for what George Kerr is able to do.

If I can be of further assistance, please let me know.

Sincerely,

John

John A. Auxier, Director
Industrial Safety & Applied Health Physics

JAA:wn

Mr. ROGERS. Thank you very much, Dr. Kerr.

Now, as I understand it, you are giving an exam if the exposure was above the 3 or the 5, 3 rems per quarter, 5 per year?

You do indicate there might be some need for followup so that if there is a medical record of some problem that a person has, that would perhaps entitle them to be examined further if they participated in these exercises?

Dr. KERR. Basically what we are going to do is first search the records at the 5 rem per year exposure, come up with a list of names. Then we will search the health records of particularly the contractors. If they have had annual physicals or termination physicals comparable to that now provided to the workers at the test site, we will take no further action.

If we find an individual who has had no medical examination, we will give him one. It could be considered comparable to the termination physical we would give a radiation worker or the immediate one we would give after an accident.

If there are medical problems, clearly the doctors will have to advise at that point. We have made no prejudgments about what we will do and hope that we can deal sympathetically with each case.

Mr. ROGERS. Well, I understand the Department of Defense now is trying to look at each case and look at the individual medical records. You do not think that is wise to do?

How many employees did you say you have covered?

Dr. KERR. Well, we have taken a very quick look at the record and that is looking, for example, from 1945 through 1960. During that period, there appear to be approximately 2,000 persons who received exposures over 5 rems. About 90 percent of these exposures occurred during Pacific operations where approximately two-thirds of the people involved were civilians and one-third military.

Of the 10 percent, the roughly 200 from on-continent testing, roughly three-quarters, in our records, were military and one-quarter of them civilians.

Now, in each case we will have to followup the health records and see what attention they got at the time and in subsequent years. If they have had the kind of attention we would give them now under our existing guidelines, we will not do anything further. Their records, however, will be available to those conducting the epidemiological study.

Mr. ROGERS. Now, if they have any medical problems, will you give them an exam?

Dr. KERR. Well, I think the answer to that is very likely the same as would be the case in a termination physical. If a man had the flu the day that we gave him the termination physical and it was not related to the conditions of his employment, we clearly would provide little or no treatment other than that immediately needed for him to seek his own personal physician.

Mr. ROGERS. I do not think you have gotten the gist of my question. Suppose he is now developing some signs in his medical history of a problem that could relate to radiation. Would that man be given an exam? It did not show up at the time he was released, but he has developed it since.

In other words, it may be 10 years after the test before it showed up.

Dr. KERR. Sir, if he is terminated from our employment, we do not plan medical followup. We do not do that under our present operating guidelines and we would not in this case, other than to provide the physical.

Mr. ROGERS. In other words, DOE is not planning any medical followup of people who have been terminated and exposed?

Dr. KERR. Not beyond what I have just told you.

Mr. ROGERS. Well, I do not think that is any more than you have ever been doing. Where is your change of policy? I do not see any change of policy.

Do you not think that these people are entitled to be advised that there may be dangers of low-level radiation exposure now? Do you think there is no danger from low-level radiation for people who were exposed,

Dr. KERR. Sir, I think I have to be careful in my answer to distinguish between the question, do you think there is a connection between disease and low-level radiation which one certainly could argue from the record your committee has developed may be the case, and the guidelines that I follow as an operating official in the Department of Energy.

Mr. ROGERS. I understand, but this is the whole point of the hearing and everyone else is adjusting. The Department of Defense already adjusted. We cannot get any movement in DOE? Is that what you are telling me?

How have you changed the guidelines since you have found that people are developing cancer and leukemia from low-level radiation exposures from Smoky, tests?

Dr. KERR. As I testified to you, first, the DOE does not set the guidelines.

Mr. ROGERS. I do not care who sets——

Dr. KERR. The Environmental Protection Agency has that responsibility.

Mr. ROGERS. I do not care who sets it. If you have personnel involved in exposure to radiation which may be causing some problems, you do not think there should be a followup, because they thought it was safe if they had a 5- or a 10-rad standard?

Dr. KERR. It is still our standard and it is still the Governmentwide standard for occupational workers in radiation industries.

Mr. ROGERS. And it is still the standard for DOD, but they are doing something about it for people who were exposed. Are you telling me now the Department of Energy is not?

Dr. KERR. That is correct. We are not changing our standards until experts in the biomedical area, which I am not——

Mr. ROGERS. I am not asking you to change standards. I am saying, are your following up the personnel exposed to radiation who were employees of yours and who have been terminated?

As I understood your answer, you say, no, we never have, we are not going to.

Dr. KERR. We do not intend to provide more followup——

Mr. ROGERS. Well, then, we want the Secretary down here. I do not think it is helpful. You evidently cannot make any policy judgment. Is that true?

Dr. KERR. That is not true, sir.

Mr. ROGERS. Well, can you make the policy judgment?

Dr. KERR. I cannot make this particular one because it involves much more than the——

Mr. ROGERS. Well, then, will you advise this committee within 1 week of your position, and if not, if there is no response to help me, I want to see the Secretary up here. We will have the Secretary appear before the committee if we cannot get any reaction from those of you who may have some responsibility for taking care of personnel exposed to radiation.

Dr. KERR. I think that part of my problem in giving a simple answer to that question is that the DOE is not the only agency in the Goverment responsible for radiation standards at the present time.

Mr. ROGERS. I am not talking about standards now, sir.

Dr. KERR. the NRC, for example, we would wish to consult with with respect to whether they would followup reactor exposures.

Mr. ROGERS. I am not talking about that. I am not talking about your setting any standards. We will go into that at a different time. I am talking about people who have been exposed.

Dr. KERR. That is correct, but they are not just people——

Mr. ROGERS. Employees.

Dr. KERR [continuing]. For whom DOE has responsibility. If one department of the Government takes this step, I think the others with similar responsibilities for radiation protection should as well.

Mr. ROGERS. Did you not hear the testimony today? That is what DOD is doing.

Dr. KERR. I believe DOD testified that they were producing a list and they were going to notify people on that list——

Mr. ROGERS. And conduct a followup.

Mr. CARTER. Mr. Chairman?

Mr. ROGERS. Yes.

Mr. CARTER. On that very thing, Admiral Sparks, who is also a physician, testified that he did have, and would provide morbidity and mortality tables of those sailors, as I recall his testimony. He thought it should be done. I went down and talked to him after that.

Mr. ROGERS. Well, obviously you are not in a position to respond to the questions the committee is asking. I think there is no point in continuing this if you are not going to take some——

Mr. HOLLISTER. Mr. Chairman, could I ask a clarifying question?

Mr. ROGERS. Certainly.

Mr. HOLLISTER. Are you asking about the followup of any DOE or contractor employee that has ever had any exposure to radiation whatsoever, even if it is below the guidelines?

Mr. ROGERS. I am asking for you, what your policy will be, as to people who are employees of yours who have had exposure to radiation, and whether there is going to be any followup of those people.

Now, you say you will give them an exam if they have had radiation exposures over the standard. But we are saying, suppose there are people who are having problems, that were never recorded as having a 5 rem exposure. What happens there? Evidently nothing.

Mr. **Hollister**. I really think, in all fairness, that we should have the week to respond. That is a very broad and sweeping question, and I think the Department needs the time.

Mr. **Rogers**. All right, you have it.

Mr. **Hollister**. Thank you.

Mr. **Rogers**. The Department of Defense said they are going to look at individual cases, look up their records, and examine subsequent medical records.

Also, it seem strange to me that you would not have already initiated this knowing the concern for low-level radiation now, and its effects. And for the Department which has responsibility for health effects research not to even do that with its own employees is a little ludicrous.

Mr. **Hollister**. I think, as I testified last time, Mr. Chairman, we need to separate two considerations. I think you have a point, that the Department should have a clear, written policy as to its medical followup of radiation workers. The reason might be for compensatory purposes or whatever the reason might be.

Mr. **Rogers**. We would hope it would be for both. First of all, I would hope it would be out of concern for the health of the individual. Second, out of concern for some valid statistics which then would allow proper action to be taken regarding standards.

Dr. **Kerr**. That is possible, but will not always be the case that they will lend themselves to research purposes, but it is possible that the United States, Government wide, or the Department might adopt some policy about compensation of people simply based on their occupation.

Mr. **Rogers**. If there is injury, they ought to have compensation.

Dr. **Kerr**. I think it is that matter that the Department has to come to some policy decisions on and to present to you in the future.

Mr. **Rogers**. Well, I think it will be helpful, because I am somewhat surprised that this has not even been dealt with. We have been talking about this for some weeks now and the Department of Defense has already moved.

Well, please let us have that. I do not see any point in continuing, unless you have some questions.

Mr. **Carter** Yes, sir, I have a few questions.

Mr. **Rogers**. Dr. Carter?

Mr. **Carter** I notice that 86 of your people were decontaminated at Baneberry. Is that correct?

Dr. **Kerr**. Yes.

Mr. **Carter** All right.

There were 900 people there, is that correct?

Dr. **Kerr**. There were approximately 900 people.

Mr. **Carter**. Approximately 900 people. All right.

Three of them developed leukemia and one developed lymphoma. Is that correct?

Dr. **Kerr**. Yes.

Mr. **Carter**. And lymphoma is known to be, and was testified by experts today, to be a radiation-related condition, is that not correct?

Dr. **Kerr**. We understand that leukemia and lymphoma may be induced by radiation, correct.

Mr. **Carter**. All right.

But yet, in your statement, on page 9 you state:

> In our opinion, there is no causal relation between the exposure to small amounts of radiation received by these individuals and their subsequent illness and death.

I want to point out one thing. Just go back to these cases at Baneberry. Four men out of 900 developed cancers, and 3 of them were out of the 86 who were decontaminated. To say that these diseases were not radiation induced is irresponsible. I cannot believe that a man could ever come to such a conclusion. We have had many statisticians here before us, Mr. Chairman, and with the precentages much less than this, they all have agreed that the figures were statistically significant.

Now, sir, do you still say that these figures are not statistically significant for causation of cancer by radiation?

Dr. **Kerr** Sir, I must respectfully direct your attention to the material that I have provided the committee where, according to our records, two of the four individuals you mentioned had no reported radiation exposure.

Mr. **Carter**. I do not find it that way. I find——

Dr. **Kerr**. On Baneberry.

Mr. **Carter**. Sir.

Dr. **Kerr**. On Baneberry.

Mr. **Carter**. I find on this the names of these people here: H. R. Robers, security guard, 4.4 rems. That is almost a yearly exposure dose. I mean maximum allowable.

And the next, W. H. Nunamaker. Of course, his was not so much. And then Mr. Reed. All three of these—Baneberry, after all three of them. What are you talking about? Do you not know what you have given, what kind of paper you have read here today?

Dr. **Kerr**. Let me read again.

> W. C. Reed, a REECo employee, received no reportable radiation exposure from the Baneberry event as determined by film badge dosimetry.

Mr. **Carter**. What?

Dr. **Kerr** [reading]:

> W. C. Reed, a REECo employee, received no reportable radiation exposure from the Baneberry event as determined by film badge dosimetry.

Mr. **Carter**. No reportable radiation. Suppose there was solarization. What happens when you have solarization of a film badge?

Dr. **Kerr**. I will defer to Bruce Church for that.

Mr. **Carter**. All right. Let's hear from Mr. Church.

Mr. **Church**. Dr. Carter, the film badge from Baneberry in no way was in the range where solarization could even have taken effect.

Mr. **Carter**. No way that the solarization could have taken effect?

Mr. **Church**. That is correct.

Mr. **Carter**. But do you know that of all the figures we have received on people who have been at these blasts, these are the highest recorded dosimetry records. The first one mentioned is the highest of all that I have seen: 4.4 rems.

Mr. **Church**. Dr. Carter, that is a beta exposure, sir.

Mr. **Carter**. That does not matter.

Mr. **Church**. Yes; it does.

Mr. **Carter**. Alpha, beta, gamma, delta—alpha, beta, gamma, neutron, or whatever you want.

Now, gentlemen, I have never heard such testimony. These people were at this event. Were they wearing badges?

Dr. **Kerr**. Yes, sir, they were.

Mr. **Carter**. Do you know whether they were wearing badges or not?

Dr. **Kerr**. Yes, sir, they were. They were wearing badges because part of the security and health protection procedure at the test site——

Mr. **Carter**. Were they among the 86 who were decontaminated?

Dr. **Kerr**. Roberts and Nunamaker are among the 86.

Mr. **Carter**. Roberts and Nunamaker.

Dr. **Kerr**. Also, you will notice from the testimony I just gave that Crawford had had a small patch of contamination on his sleeve that was removed.

Mr. **Carter**. Gentlemen, it just seems to be that you are obfuscating and trying every way that you can to escape the responsibility for which the Atomic Energy Commission is, without doubt, responsible. There is no question in my mind of this.

If you take only two of the men's records and discount the other two, both of which had radiation-related cancerous diseases, the figures are still statistically significant. Yet you sit here and deny that.

It is very, very surprising, to hear such testimony, and I deplore the fact that anyone could do that.

Thank you, Mr. Chariman.

Mr. **Rogers**. Just let me ask you this, on the followup on Baneberry, we requested a followup on the 900 men at the work camp in Baneberry. Has this been done?

Dr. **Kerr**. We have identified the names, to date, sir, of 883 of those people and, as I have testified earlier, these actions that require a detailed search of our records are the ones we promise to complete for you by the end of March.

Mr. **Rogers**. Of the 883. And you will give us a status report on their health?

Dr. **Kerr**. That was not a thing we could program easily at this point. We can report to you on those that had exposures, a smaller number of people. The total number of people, particularly those with no reported exposure we had not intended to report on, but simply to tell you that they had zero exposure.

Mr. **Rogers**. If there is no followup, how do we know what has happened with those people. Maybe they have developed leukemia. How can we know, unless you make some check of those 900?

Mr. **Church**. Mr. Chairman, you are suggesting that all of the sickness that they have would be caused by very insignificant amounts of radiation.

Mr. **Rogers**. That is exactly the possibility, sir, that I know some of you in the energy field do not believe yet. But we are having reports and studies where leukemias show up for low-dose exposure to radiation. That is the whole point here. In fact, we have had scientists come before us to say the standards that you use—and are used all over by everyone—of 3 rem per quarter and 5 rem per year is far too high, far too high.

So what we are saying is that these people who may not trigger any concern in your particular agency, perhaps because they did not get all at one zap doses of 3 or 5 rem, there still may be a health problem with these 900 from Baneberry.

With that exposure, we think they are entitled to be checked to see what their health status is and if there is a problem with leukemia or with cancer, it ought to be carefully checked to try to determine the cause, because it may well have come from Baneberry.

Mr. CHURCH. Sir, I think the concern we have in trying to understand your request is this. If the exposure for an individual who was present at the test site is background—that is, no added exposure from his presence at Baneberry—it is very hard for us to see how you can relate 0 added exposure to whatever health problems may have developed.

Mr. CARTER. Mr. Chairman, this could be answered by ingestion of particles. These men were covered up by dirt and dust from that and there is no doubt that they ingested a lot of that. Much of it was alpha, and I understand that alpha does not register on the film badge, is that not correct? Is that not correct?

Mr. KERR. That is correct.

Mr. CARTER. And it can cause leukemia, and those two men you mentioned there could very well have ingested alpha particles, is that not correct? And it would not have shown on their film badges.

And furthermore, your statitics suit you. When you can disprove anything, you use them that way, just as you knew that 1 man out of these 900 had 2 lymph glands some weeks before that, but you cannot tell us any physical disabilities about anyone else. Nothing except that one man.

Your testimony just goes to suit you, without regard to principle or truth or anything else, as I see it.

Mr. HOLLISTER. Mr. Chairman, could I comment?

Mr. ROGERS. Certainly.

Mr. HOLLISTER. I believe I tried to reach this point in my testimony last time. I could very well see the Government or the Department adopting the policy that anyone—and, by the way, I am not advocating this policy at this point—that anyone contracting leukemia who had been occupationally exposed to radiation sometime during his employment under the Department is, ipso facto, a case for compensation or whatever else the Government wants to do.

I could very well see the Government adopting such a policy, in which case, in order to implement it, you would need to track down the records of everyone who had been occupationally exposed. You would attempt, perhaps, for the interest of the matter to find out how much he had gotten. You would have medical followup until his death to see what his future medical history was and if, at any time, he contracted, say, leukemia or certain other classes of disease you might, as a matter of policy, decide to compensate that individual or his family or whatever.

That is, in my view, an entirely separate question from the scientific question of whether or not that radiation was the cause of the leukemia, and I think that the tangling up of the research question, which is a very difficult question—I do not claim to be a research investigator myself, but I know enough about the subject to know that it is a difficult question of research, that and the compensation question or what other just, compassionate action you may have in mind for the Government are two separate questions.

I think if they are attacked separately then the committee could make progress in what I think you are after.

Mr. ROGERS. Well, may I be permitted to comment, Mr. Hollister, that I have not confused it, I know exactly the true question. I did not ask you for any explanation. What I am asking for is a follow-up to find out if there is a relationship between radiation exposure and leukemia. Now, you found from Baneberry, that three had leukemia, one of whom you say was not exposed?

Mr. KERR. That is correct, three people who had leukemia and one deceased.

Mr. ROGERS. But how many of the other records of those who were there and exposed have you looked at? You haven't completed any study. You said you won't do it until March 29, didn't you?

Dr. KERR. That is correct.

Mr. ROGERS. Well, if you had as high a rate as this among those whom you knew were exposed, doesn't that cause a little concern that there may be more in 900? There are four cases that you know of. Without looking at the records of what's happened to the others you certainly can't conclude that these cases weren't due to radiation. You may have an extremely high rate. It may get as high as "Smoky," 8 out of 400, which would be a rather high rate, would it not?

Dr. KERR. Yes, sir, it would.

Mr. ROGERS. Do you see the point I am trying to make?

Dr. KERR. I see the point you are making.

Mr. ROGERS. Does it have any validity?

Dr. KERR. We don't lack confidence in our ability to provide that information for you. We have the names, we have the exposure records.

Mr. ROGERS. I am not talking about exposure records. You see, all of you want to go on an exposure record. We have been driving at the whole point, that if they are present at an exposure, we at least ought to look at their medical records since then to determine if, contrary to your current belief, that anyone exposed below 3 rem, for a quarter, or 5 per year, may still be adversely affected by lower radiation exposure, do you see my point?

Mr. CHURCH. I understand your point.

Mr. ROGERS. Do you disagree with it?

Mr. CHURCH. I disagree with it, right.

Mr. ROGERS. Why?

Mr. CHURCH. Well, for several reasons. First of all, we all incur background readiation an if I am to look at a large number of people I am going to find medical maladies, and if I find——

Mr. ROGERS. Yes; but don't you have a statistical amount that would be normal for that group?

Mr. CHURCH. Well, I am not suggesting it would be normal or abnormal.

Mr. ROGERS. If it is background, you have a normal number.

Mr. Church. OK. You have suggested that the Baneberry leukemias are abnormal.

Mr. Rogers. Well, I would say if you have already got 4 and haven't even looked at 883 out of 900, wouldn't you say——

Mr. Church. For no more reason than we would look at all the rest of the occupational employees.

Mr. Rogers. Well, which is may well what you would do, except that you are also being sued, are you not?

Mr. Church. That is correct.

Mr. Rogers. Is that correct?

Mr. Church. That is correct.

Mr. Carter. What is your background, sir?

Mr. Church. I am a health physicist by training.

Mr. Carter. Health physicist. Are you Ph. D.?

Mr. Church. I have a master's degree.

Mr. Carter. You have your master's degree?

Mr. Church. Yes.

Mr. Carter. You all admit that ingestion of alpha particles does change the film, is that correct?

Mr. Church. It does not affect the film badge.

Mr. Carter. All right.

Mr. Church. But we use other methods to measure the internal deposition of radio nuclides. In the case of Baneberry, we did urinalysis, thyroid scans, et cetera, to measure other possible internal deposits.

Mr. Rogers. Now, just a minute. Out of how many of those exposed did you take urine samples?

Mr. Church. Out of 86.

Mr. Rogers. That were exposed?

Mr. Church. That were decontaminated.

Mr. Rogers. You didn't take urine samples out of the others?

Mr. Church. That is correct, because——

Mr. Rogers. How did you decide the 86?

Mr. Church. Because the others were monitored and we did not find any contamination on them.

Mr. Rogers. Simply because your little badge didn't show radiation?

Mr. Church. Negative. Because we were using portable instruments to monitor the persons of those individuals and if any contamination had been observed, those individuals would have been decontaminated during the same time frame that the 86 were.

Mr. Rogers. Would you have observed alpha contamination in the lungs?

Mr. Church. We would have observed it if it would have been on the surface of the clothes.

Mr. Rogers. On the surface of the clothes, but not in the lung?

Mr. Carter. It couldn't have been.

Mr. Church. Mr. Chairman, it would not selectively be in the lung and not on the clothing.

Mr. Carter. You decontaminated them, though, before you checked them for radiation, did you not?

Mr. Church. Negative. We monitored the 900 people as they left the area 12 camp, and the ones we found contamination on the clothing, they were decontaminated.

Mr. ROGERS. Within what period of time?

Mr. CHURCH. Within a few hours.

Mr. ROGERS. Were they walking around?

Mr. CHURCH. I am not sure I understand your question.

Mr. ROGERS. Did they all stay in position, did they shake the dust of themselves, or what?

Mr. CHURCH. As they came in by busload and carload, they were monitored and segregated and those with observable contamination went to the decontamination facility.

Mr. ROGERS. Let me ask you this, would it be natural for them, if they had some dust drop on them out there, for them to shake it off before they got off on the bus?

Mr. CHURCH. I imagine that would be natural.

Mr. ROGERS. Why of course, and you didn't monitor them when they got on the bus, you waited until they got to the camp and did it there.

Mr. CHURCH. That is correct, we were doing an evacuation, but you are not going to shake it all off.

Mr. ROGERS. Well, you may not have found it all, either.

Mr. CARTER. Urine samples were taken for many of these personnel; it doesn't say how many.

Mr. ROGERS. Well, I think Dr. Carter——

Mr. CARTER. Yes, sir.

Mr. ROGERS. We have pursued this sufficiently. We would like to know your policy in this matter and if you are going to follow up the others regarding adverse health effects and not just get their names. The committee will follow this closely. Thank you for being here and giving us this additional information. We will ask you to submit that to us within the week, if you can.

Dr. KERR. We will do that, Mr. Chairman, thank you.

Mr. ROGERS. And then you may advise the Secretary that we may desire his presence here shortly thereafter. Thank you for being here.

The last witness today is Dr. Paul A. Haber, Assistant Chief Medical Director for Professional Services of the Veterans Administration.

STATEMENT OF PAUL A. HABER, M.D., ASSISTANT CHIEF MEDICAL DIRECTOR FOR PROFESSIONAL SERVICES, VETERANS ADMINISTRATION, ACCOMPANIED BY C. J. PECKARSKY, DIRECTOR, COMPENSATION AND PENSION SERVICE, DEPARTMENT OF VETERANS BENEFITS; JAMES J. SMITH, M.D., DIRECTOR OF NUCLEAR MEDICINE SERVICE, DEPARTMENT OF MEDICINE AND SURGERY; LAWRENCE O. HOBSON, M.D., DEPUTY ASSISTANT CHIEF MEDICAL DIRECTOR, RESEARCH AND DEVELOPMENT; SYDNEY J. SHUMAN, CHAIRMAN, BOARD OF VETERANS APPEALS; AND CHARLES JOHNSTON, ASSISTANT GENERAL COUNSEL

Mr. ROGERS. Dr. Haber, we appreciate your presence, you and your colleagues.

Dr. HABER. Thank you very much, Mr. Chairman. I have a brief statement.

Mr. ROGERS. That would be fine, if you would proceed with that. Without objection, the full statement will appear in the record.

Dr. HABER. I would like with the committee's permission to introduce my colleagues.

Mr. ROGERS. Certainly.

Dr. HABER. They may be helpful in answering questions.

Mr. ROGERS. Yes.

Dr. HABER. James J. Smith, M. D. Director of Nuclear Medicine Service, Dr. Lawrence Hobson, Deputy Assistant Chief Medical Director for Research and Development; Mr. Charles Johnston, Assistant General Counsel; Mr. Sydney Shuman, Chairman, Board of Veterans Appeals; and Mr. Charles Peckarsky, the Director of Veterans Benefits of the Compensation and Pension Service Department.

Mr. ROGERS. Thank you. We welcome all you gentlemen to the committee and are sorry to have held you so long.

Dr. HABER. Thank you, Mr. Chairman.

I am pleased to appear before the subcommittee today to outline the action which the VA has taken since we last appeared before you on January 26, 1978, in regard to the health effects of ionizing radiation. The transcript of that hearing has been returned and the requested information supplied.

Following those hearings on the health effects of ionizing radiation, the Department of Medicine and Surgery of the Veterans Administration has extended the scope of its activities described in the hearing, as well as engaging in new actions as dictated by the course of events.

A task group to act as liaison with other Federal agencies having cognate interests in the participation of U.S. military personnel in nuclear testing, has been organized. This group will be consultative to the VA in matters pertaining to exposure of service personnel to radiation, and it will be free to enlist the skills of experts other than themselves whenever circumstance warrant further opinion.

In effect, Mr. Chairman, this committee will be our action agency as requested by other agencies with whom we wish to cooperate. And it will pursue the Veterans Administration's interests in this matter, in coordination with those agencies.

In addition, a professional services letter to all VA health care facilities specifying the actions to be taken for the medical evaluation of veterans who were present at nuclear device testing is in its final draft form, and it will be sent out shortly. And we will supply a copy of that to the committee.

Mr. ROGERS. That would be helpful.

Dr. HABER. Very good, sir.

Close contact with the Armed Forces Radiobiological Research Institute has been maintained since their nationwide broadcast soliciting nuclear device testing veterans to identify themselves by calling 800-638-8300.

Furthermore, VA physician attended an interagency discussion at the Pentagon on February 10, 1978 under Vice Admiral Monroe, who testified earlier here, at which group experts from AFFRI, CDC, DNA, DOE, GSA, HEW, Nuclear Regulating Committee, Office of Scientific Development, U.S. Air Force, U.S. Navy and the White House were present.

In this meeting, chaired by Vice Admiral Monroe, Director of DNA, the topics of DOD and DOE plans of action, the status of the

CDC effort—scope, methodology, and timing—and that of the proposed NAS scope, methodology, and timing effort, and the HEW outlook on both, were discussed. The relevance of these issues to the VA was delineated and the White House position on the overall issue was stated.

The specific issues of exposure criteria, identification of personnel (GSA, IRS, et cetera), notification of personnel, and medical followup were addressed.

Telephone consultations concerning the death from leukemia, at the Boise, Idaho VAH, of one of the participants in the Smoky exercise, were held with Dr. Glyn Caldwell of CDC, and the Chief of Staff of the VA health care facility.

I might say, sir, that several of the people here have been in touch with Dr. Caldwell, have furnished him data and stand ready to furnish him further data as requested and required.

Arrangements were made for Dr. Gary Stein, of the CDC, to obtain post morten specimens from the deceased veteran, for examination in several laboratories, including that of the EPA.

Mr. Chairman, this concludes our statement. We are available to answer any question that you might have.

I would like to also add, Mr. Chairman, that we are also cooperating with another group on background radiation, the National Council on Radiation Protection for other forms of ionizing and nonionizing radiation and we will cooperate with them.

Mr. ROGERS. Thank you very much. Now, as I understand it, all the records at CADC might be available?

Dr. HABER. Yes, sir.

Mr. ROGERS. There is no problem there?

Dr. HABER. No, sir.

Mr. ROGERS. Interchange of Department records may be needed?

Dr. HABER. No, sir.

Mr. ROGERS. National Academy of Sciences.

Dr. HABER. Right.

Mr. ROGERS. Well, I think that is a very constructive step I also notice you are sending out a letter to all VA health care facilities.

Dr. HABER. Yes, sir. The purpose of that letter would be to notify our physicians on the proper course of action to take when such veterans apply for hospitalization.

Mr. ROGERS. And what about for claims? Are you sending out a directive to your regional offices on that too?

Dr. HABER. I would defer to Mr. Peckarsky on that question?

Mr. ROGERS. Yes, sir.

Mr. PECKARSKY. Our directions to our regional offices remain unchanged, Mr. Chairman. Since 1967 they have been instructed to send us a copy of every decision on every claim involving exposure to radiation. We have as yet formulated no change in policy, mainly because the issue is one for investigation, and it would be premature to establish new policy until the investigations are complete.

Mr. ROGERS. Yes; but the only thing I was wondering about concerns some testimony we had that some claims were simply being rejected by the regional offices because they said, "Well, you can't prove you were there," although the records that we have at the Department of Defense would provide that proof.

Mr. PECKARSKY. Yes, sir. And we are asisting our offices in establishing all the evidence that is available. We have very good relationship with both DOE and DOD in establishing whatever records they have.

Mr. ROGERS. So a claim would not be rejected on that basis?

Mr. PECKARSKY. No, sir. On the other hand, exhaustive investigation, as the committee will know in seeing some of the cases, has disclosed no record of radiation from any source, even though we have exhaustively investigated it.

Mr. ROGERS. Excuse me. I didn't understand.

Mr. PECKARSKY. Many of the claims of alleged exposure, we have exhausted every avenue available to us and still find no record of any exposure, no record of any radiation. These are sort of dead-ends for us.

Mr. ROGERS. Oh, yes, when there is no record at all.

Dr. HABER. Right.

Mr. ROGERS. But what I am saying is that I presume the Department records and AEC records will now be scanned and examined before a claim is rejected, in cases where a man claims he was at a certain test shot.

Dr. HABER. We are doing that either before it is rejected or after it is rejected, as soon as we note the rejection.

Mr. ROGERS. Yes.

Mr. PECKARSKY. If there is no evidence exhaustively rejected, we do it.

Mr. ROGERS. Dr. Carter.

Mr. CARTER. When were you first aware that these names were available, added to the Atomic Energy facility? When were you aware that this 1970 group of names had been called for by Congressman Teague and had been found, had been located?

Mr. PECKARSKY. At that point in time, Mr. Carter.

Mr. CARTER. When were you made aware of this?

Mr. PECKARSKY. Very soon after Chairman Teague, who was then the chairman of the House Veterans Committee, addressed the correspondence. He sent us a copy of it.

Mr. CARTER. Yes, sir. How do you verify a veteran's claim about exposure from these tests while in service?

Mr. PECKARSKY. Yes, sir.

Mr. CARTER. How do you do this? How do you verify a veteran's claim about radiation exposure from these tests while in service?

Mr. PECKARSKY. We follow our normal procedure of development of evidence. We write to the Service Department, tell them what is alleged, ask them to verify and send us all the records available concerning the allegation of the claimant.

Mr. CARTER. Yes, sir, most of these film badge records are kept a Bluegrass Ordinance. Do you write to them, or do you just——

Mr. PECKARSKY. We also correspond with the Department of Energy, which we have been informed is now the repository for records formerly held by the Atomic Energy Commission.

Mr. CARTER. In the case of Russel Jack Dan, he was denied his claim because the VA told him the service's report said that he had had no exposure to radiation. Carl J. Hartstern has been told the service reports no exposure to radiation. Archie McBride's widow's claim was denied, and again VA says service reports no exposure to radiation.

In each of these cases each person is on the list CDC has of Smoky participants, along with the cemetery records. And on the master list for Smoky, held by Major Stock.

Now, gentlemen, could they make such an error as this, say these people, that he had no exposure to radiation, when you have records?

Mr. PECKARSKY. We have a record, Dr. Carter, in that particular case of 2,240 millirem and 620 millirem EP data.

Mr. CARTER. Well, you are revising your statement when you denied his claim, when you said to him that service reports no exposure to radiation.

Mr. PECKARSKY. Yes, sir.

Mr. CARTER. Isn't that your statement?

Mr. PECKARSKY. Yes, sir, as I told him.

Mr. CARTER. That was your statement. Was it correct?

Mr. PECKARSKY. Yes, sir, at that time.

Mr. CARTER. When did you get the reading, then?

Mr. PECKARSKY. We subsequently developed the additional source of data that we had made available to us through the Department of Energy. As I pointed out to the chairman, we do after-the-fact development as if we can't find records done before.

Mr. CARTER. What about Karl J. Hartstern, now? The service reports no exposure to radiation for him. Have you found out anything about him?

Mr. PECKARSKY. What was that name, sir?

Mr. CARTER. Karl J. Hartstern, from Wisconsin, Madison, Wis. No, Green Bay, Wis.

You denied him, "service reports no exposure," and yet we have these records at CDC.

The same thing goes for Mr. McBride's widow. It goes on and on.

Mr. PECKARSKY. I do not have a record of the claim from Mr. Hartstern.

Mr. CARTER. Archie McBride, who is deceased.

Mr. PECKARSKY. Pardon me.

Mr. CARTER. Archie McBride, who is deceased. His widow is making, presenting a claim.

Mr. PECKARSKY. Yes, sir, the badge in that case in Smoky showed zero.

Mr. CARTER. Showed zero?

Mr. PECKARSKY. Yes, sir, that was the report to us.

Mr. CARTER. Well, in answer to that, "service reports no exposure to radiation." Now, he could have very well have ingested alpha particles and his badge would have been negative, is that correct?

Mr. PECKARSKY. Yes, sir.

Mr. CARTER. All right. Well, that doesn't mean that he wasn't exposed because his film badge didn't show exposure levels, it doesn't mean he wasn't exposed, does it?

Mr. PECKARSKY. No, sir.

Mr. CARTER. All right. Very well, thank you for that. Do you think that the VA should be establishing some better way of finding records and that it need not wait until the direct correlation is established to do so. Don't you think you should have a better record system of finding out about these things? You know, time after time you denied that Donald Coe was out at Smoky. And that all these things were denied. So many times. Don't you think you should computerize your files and your records?

Mr. PECKARSKY. Dr. Carter, one of my primary concerns is the completeness, the availability, and the accessibility of records. We handle in excess of 2.7 million claims for benefits per year.

Mr. CARTER. Yes, sir.

Mr. PECKARSKY. The more we can expedite the handling of those claims, and the better accessibility to records we have, the easier my job is. It obviously is very desirable for me to have the most accessible record system possible. We have the best computer system we have been able to devise thus far, and have been privileged by the Congress to completely revise our computer system over the next 5 years, which is a major undertaking. Hopefully that will make records even more accessible and make my job a lot easier.

Meanwhile, we struggle along with what we have and try to do the very best we can with what is presented.

Mr. CARTER. You struggle along with what you have, but you know the Congress gives you just about everything that you want. I don't know the time that you have ever been turned down for anything, that any veterans legislation that has come before the House has been turned down, never.

Mr. PECKARSKY. Having just had a hearing before the subcommittee on appropriations, that is slightly open to question, sir.

Mr. CARTER. Well, I don't know what they are doing these days, but I hope we do better. Anyway, gentlemen, I hope that we someway retrieve the data more correctly. If I can get a list of Quantrell's guerrillas quicker than you can get a list of these, there is something rotten in Denmark.

Thank you.

Mr. ROGERS. May I ask how many have been in contact with the veterans service people, regarding being exposed to radiation from nuclear devices?

Mr. PECKARSKY. Out total claims number, I believe, 148, as we furnished the committee.

Mr. ROGERS. I notice in the statement of Dr. Haber on page 2 he says:

> Close contact with the Armed Forces Radiobiological Research Institute has been maintained since their nationwide broadcast soliciting nuclear device testing veterans to identify themselves by calling 800-638-8300.

They mentioned 2,500, from the telephone calls. I wondered if you had gotten any in addition to that, or any letters in addition to that?

Dr. HABER. To the best of my knowledge, sir, we have not. But we are going to obviously in our letter query the field also.

Mr. ROGERS. Would you let us know?

Dr. HABER. Yes, sir, we shall. We will be very alert to that question.

Mr. ROGERS. And we have some questions we will ask for the record? Thank you.

Dr. HABER. Yes, thank you.

[Testimony resumes on p. 1206.]

[The following material was received for the record:]

DATE: FEB 1 7 1978

TO: Dr. Paul Haber, Assistant Chief Medical Director (11)
Mr. Sydney Shuman, Chairman Board of Veterans Appeals (01)
Mr. J. C. Peckarsky, Director, Compensation and Pension Svc. (21)
Mr. John DeLeo, Assistant General Counsel (024)

FROM : Assistant General Counsel (023)

SUBJ : Information for hearing record in connection with the hearings on radiation conducted by the Subcommittee on Health and the Environment of the House Committee on Interstate and Foreign Commerce on February 14, 1978

1. Attached please find a series of questions supplied to us at the hearing on February 14, 1978, by the Subcommittee on Health and the Environment of the House Committee on Interstate and Foreign Commerce.

2. The questions seem to be addressed primarily to adjudication and privacy. However, if any of you believe that a particular question is in your area of responsibility, I would be happy to receive your suggestions.

3. In order to respond to the questions, I would appreciate your views and suggestions as soon as possible.

Charles M. Johnston
CHARLES M. JOHNSTON

Attachments

QUESTIONS AND RESPONSES TO PRIVACY ACT

The following answers are submitted in response to the Privacy Act questions raised by the Subcommittee on Health and the Environment of the House Committee on Interstate and Foreign Commerce at the February 14, 1978, "Smoky" hearings:

(1) Q. What is the VA's policy with respect to disclosing personal and/or medical records to another Federal agency doing epidemiological research which has important public health implications?

A. The VA's policy on disclosure of personal and/or medical records to another Federal agency doing epidemiological research is to release relevant information contained in such records if the agency indicates that such disclosure is necessary to accomplish a statutory purpose of that agency. Our confidentiality statute, 38 U.S.C. 3301, provides for such disclosures to Federal agencies. Moreover, Privacy Act routine uses are in effect which allow such disclosures.

(2) Q. What is the process by which a request for such information under the authority of the Privacy Act is evaluated in the VA?

A. The VA has not established a formal procedure for processing requests from other Federal agencies for disclosures for epidemiological research. Within the past year, however, it was determined that disclosure of this type should be handled in a standard, somewhat formalized manner. Accordingly, the VA is now developing a procedure for handling requests of this nature from both Federal and non-Federal researchers.

(3) Q. What guidelines or criteria are used to evaluate such a request?

A. As indicated in our answer to question 2, formal guidelines or criteria have not been used in evaluating a request. Under informal procedures we have evaluated such requests on the basis of whether an appropriate Federal agency official had made the request and whether the disclosure was required to accomplish a statutory purpose of the Federal agency. Also considered have been the research purpose, whether the researchers are qualified, and the integrity of the researcher for maintaining confidentiality of any personal information collected. These and other factors are being considered for formal adoption as the criteria by which epidemiological disclosure requests will be considered in the future.

(4) Q. How long does the process usually take to reach a decision on a request for personal and/or medical records under the Privacy Act?

A. The processing of disclosure requests from other Federal agencies for personal or medical records varies with the type of information requested, the method by which the information is maintained and the location of the records. Where the records are reasonably available, the time from receipt of a request to disclosure is usually a matter of a few weeks.

(5) Q. Who makes the final decision?

A. A Federal agency request for disclosure of epidemiological information from VA compensation and pension records usually comes to Central Office. The decision on claims records disclosures is usually a matter for the Chief Benefits Director. Regarding medical records, the decision generally is for the Chief Medical Director.

(6) Q. Is there any opportunity for appeal or reconsideration?

A. An opportunity for appeal or reconsideration of any refusal to disclose is afforded to a requester. The Administrator is the final agency appellate authority.

(7) Q. Has your authority to release personal and/or medical records changed over the last year? If so, how?

A. VA authority to release personal and/or medical records in this area has changed over the last year to the extent that routine uses have been adopted to authorize disclosures for epidemiological purposes to Federal agency requesters. (See attachments).

(8) Q. Please cite any requests for personal and/or medical records by other Federal agencies for epidemiological research which the VA has had in the last 3 years, and the actions which you took on such requests, and the justification for such actions.

A. Federal agency epidemiological research requests within the last three years have included the Center for Disease Control (re the subject radiation study, treatment of swine flu); the Department of State (re radiation exposure in foreign embassies); and the National Institute of Health (re lung cancer and smoking). These requests were honored under 38 U.S.C. 3301 and appropriate routine uses.

(9) Q. Please provide a chronological list of the requests (both formal and informal) made by the Center for Disease Control to the VA for information on "Smoky" participants for the purpose of conducting an epidemiological study, and a status report on which information has been provided, and which information has been denied and why. If any requests are pending, please indicate the date by which you expect a decision will be made.

A. We do not have an absolute chronology of Center for Disease Control requests for information on "Smoky" participants. Most requests have been made by telephone and were processed within one or two weeks from the date of the request. One written request was made by Dr. Glyn Caldwell on November 16, 1977 (copy attached). Eighty percent of the information requested was supplied to Dr. Caldwell within approximately two weeks of the date of his written request. The VA is searching for the remaining information, which is located in files which are not readily accessible. The information is in inactive files which have been transferred to the Federal Archives Record Center and are not retrievable except by a written request for recall from the VA Regional Office of jurisdiction. These requests are being submitted as the Regional Offices having such jurisdiction are identified. In no instance has the VA intentionally blocked a request from the CDC. Indeed, the VA desires to cooperate fully with the CDC.

(10) Q. Under the Privacy Act, section 552a(b) lists conditions of disclosure under which records may be disclosed to another agency without prior written consent of the individual(s) involved. In particular, condition #(8) of section 552a(b) is:

> "to a person pursuant to a showing of compelling circumstances affecting the health or safety of an individual if upon such disclosure notification is transmitted to the last known address of such individual;"

Could the Center for Disease Control's request for records of "Smoky" participants be authorized under condition #(8)?
If not, why not?
(Please see attached letter from the National Cancer Institute to the Civil Service Commission, and the statement authorizing release of such material pursuant to sections 552a(b)(2) and 552a(b)(8), cited above.)

A. In our opinion 5 U.S.C. 552a(b)(8) would not be clear authority for disclosure to CDC of information from all "Smoky" participants' records. No immediate "clear and present danger" to the health and safety of this entire class has been presented. As to particular individuals, disclosure under this authority might be indicated; however, it should be noted that the purpose of the CDC request in this case is understood not to be to warn individuals or to treat them, but merely to study them for research purposes. This appears to be considerably removed from a disclosure for the purpose of alleviating an acute medical or safety emergency, as we believe is contemplated by 5 U.S.C. 552a(b)(8).

(11) Q. Has the VA ever contracted with another Federal agency to do a study or project, and then disclosed personal and/or medical records by virtue of that contractual relationship, which might not otherwise be permitted to be disclosed under the Privacy Act? Could the VA contract with the Center for Disease Control and thereby authorize the disclosure of records which the CDC needs to conduct its study on "Smoky" participants?

A. Since the enactment of the Privacy Act of 1974, we are unaware of any disclosures of personal or medical records information to Federal agencies with which the VA had a contract, which would not have otherwise been disclosable under the Privacy Act had there been no such contract agreement. The VA may have statutory authority to enter into an agreement with CDC to accomplish a purpose under title 38, U.S. Code. It would appear that under such circumstances, disclosure of records incident to that agreement would be authorized. Nevertheless, a possible contracting approach is unnecessary in light of the VA's authority under title 38, U.S. Code, and Privacy Act routine uses.

(12) Q. Does the National Academy of Sciences' National Research Council Medical Follow-up Agency have access to personal and/or medical records which Federal agencies are not allowed? If so, why?

A. To the extent that the National Academy of Sciences' National Research Council Medical Follow-up Agency serves as a VA contractor subject to section (m) of the Privacy Act of 1974 (5 U.S.C. 552a(m)), performing duties for the VA, it may have access to information from personal or medical records which may not be available to Federal agencies generally. Such would occur where a Federal agency did not have a statutorily based need for the information in question, or where records of drug, alcohol, or sickle cell anemia treatment made confidential by 38 U.S.C. 4132, are involved.

(13) Q. Could the VA, if asked by another Federal agency for the purpose of conducting epidemiological research, send information to the last known address for an individual on whom it has a file or record, to ask permission to disclose such record?

A. If a Federal agency, for the purpose of conducting epidemiological research, requested that the VA send information to an individual regarding whom the VA maintains a record, to his last known address, asking for consent to disclose information from such record, the agency could do so, on a reimbursable basis, subject to availability of facilities and personnel.

(14) Q. Does the VA have a "routine use" listing or listings for the record systems which the Center for Disease Control needs to conduct its epidemiological study on "Smoky" participants? If so, please cite all relevant "routine use" listings.

A. The pertinent VA Privacy Act routine uses which would allow the VA to provide the CDC with information needed from VA Records Systems to conduct its epidemiological study of "Smoky" participants are attached for your convenience.

24VA136

System name: Patient Medical Records-VA

System location: Records are maintained at each of the VA health care facilities and the Federal records centers. Address locations for VA facilities are listed in VA Appendix 1 at the end of this document.

Categories of individuals covered by the system: Veterans, survivors and dependents of certain veterans who have applied for health care services under Title 38, United States Code, Chapter 17. Patients other than the above who were admitted to a hospital under emergency conditions for humanitarian reasons.

Categories of records in the system: Medical Records contain a cumulative account, written in graphic form, of sociological, diagnostic, medical, surgical, dental, drug and alcohol information compiled by VA professional staff and private hospitals and doctors, information relating to dependency, income, education and occupation. Counseling and Rehabilitation records are also maintained as necessary.

Authority for maintenance of the system: Title 38, United States Code, Chapter 3, Section 210(c)(1). Title 38, United States Code, Chapter 17.

Routine uses of records maintained in the system, including categories of users and the purposes of such uses:

1. Disclosure of medical record data as deemed necessary and proper to Federal, State and local government agencies and national health organizations in order to assist in the development of programs that will be beneficial to claimants and to protect their rights under law and assure that they are receiving all benefits to which they are entitled.

2. Disclosure of medical care furnished and the period of care, as deemed necessary and proper to accredited service organization representatives and other approved agents, attorneys, and insurance companies to aid claimants in the preparation, presentation and prosecution of claims under laws administered by the VA, State or local agencies.

3. In the event that a system of records maintained by this agency to carry out its functions indicates a violation or potential violation of law, whether civil, criminal or regulatory in nature, and whether arising by general statute or particular program statute, or by regulation, rule or order issued pursuant thereto, the relevant records in the system of records may be referred, as a routine use, to the appropriate agency, whether Federal, State, local or foreign, charged with the responsibility of investigating or prosecuting such violation or charged with enforcing or implementing the statute, or rule, regulation or order issued pursuant thereto.

4. A record from this system of records may be disclosed to a Federal agency, in response to its request, in connection with the hiring or retention of an employee, the issuance of a security clearance, the reporting of an investigation of an employee, the letting of a contract, or the issuance of a license, grant, or other benefit by the requesting agency, to the extent that the information is relevant and necessary to the requesting agency's decision on the matter.

5. A record from this system of records may be disclosed as a 'routine use' to a Federal, State or local agency maintaining civil, criminal or other relevant information, such as current licenses, if necessary to obtain information relevant to an agency decision concerning the hiring or retention of an employee, the issuance of a security clearance, the letting of a contract, or the issuance of a license, grant or other health, educational or welfare benefit.

6. Disclosure of conditions of named patients by appropriate professional staff members of health care facilities to families and friends of those named patients.

7. Disclosure by health care facilities information desks of 'on the rolls' status of named individuals in response to inquiries and/or for visitation purposes.

8. Relevant information from this system of records may be disclosed as a routine use: in the course of presenting evidence to a court, magistrate or administrative tribunal, in matters of guardianship, inquests and commitments; to private attorneys representing veterans rated incompetent in conjunction with issuance of Certificates of Incompetency; and to probation and parole officers in connection with Court required duties.

9. Relevant information from this system of records, including the nature and amount of a financial obligation, may be disclosed as a routine use, in order to assist the Veterans Administration in the collection of unpaid financial obligations owed the VA, to a debtor's employing agency or commanding officer so that the debtor-employee may be counseled by his or her Federal employer or commanding officer. This purpose is consistent with 5 U.S.C. 5514, 4 CFR 102.5, and section 206 of Executive Order 11222 of May 8, 1965 (30 F.R. 6469).

10. Release of information to a guardian ad litem in relation to his or her representation of a claimant in any legal proceeding.

11. Disclosure may be made to a congressional office from the record of an individual in response to an inquiry from the congressional office made at the request of that individual.

12. A record containing the name(s) and address(es) of present or former members of the armed services and/or their dependents may be released from this system of records under certain circumstances: (1) to any nonprofit organization if the release is directly connected with the conduct of programs and the utilization of benefits under Title 38, and (2) to any criminal or civil law enforcement governmental agency or instrumentality charged under applicable law with the protection of the public health or safety if a qualified representative of such organization, agency or instrumentality has made a written request that such name(s) or address(es) be provided for a purpose authorized by law; provided, further, that the record(s) will not be used for any purpose other than that stated in the request and that organization, agency or instrumentality is aware of the penalty provision of 38 U.S.C. 3301(f).

13. For the purpose of justifying emergency leave, disclosure to the Red Cross of the nature of the patient's illness, probable prognosis, estimated life expectancy and need for the presence of the related service member.

14. A record from this system of records may be disclosed to attorneys, insurance companies, employers, and to courts, boards, or commissions to the extent necessary to aid the Veterans Administration in preparation, presentation, and prosecution of claims authorized under Federal, State, or local laws, and regulations promulgated thereunder.

15. Disclosure of medical record data, excluding name and address, (unless name and address is furnished by the requester) for research purposes determined to be necessary and proper, to epidemiological and other research facilities approved by the Chief Medical Director.

16. The name(s) and address(es) of present or former personnel of the armed services and/or their dependents may be disclosed to the Department of Health, Education, and Welfare, or agency thereof, or other Federal agency, at the written request of the head of the agency or designee of the head of that agency, for the purpose of conducting government research necessary in order to accomplish a statutory purpose of that agency.

17. To the Department of Justice and United States Attorneys in defense or prosecution of litigation involving the United States.

18. Disclosure of information from the record of an individual may be made by the examining VA physician to a non-VA physician, when that non-VA physician has referred the individual to the VA for medical care.

19. Disclosure may be made to NARS (National Archives and Records Service) GSA (General Services Administration) in records management inspections conducted under authority of 44 U.S.C. 2904 and 2906.

Policies and practices for storing, retrieving, accessing, retaining, and disposing of records in the system:

Storage: Paper documents, Microfilm, Magnetic tape, Disk.

Retrievability: (a) Manual records are indexed by name and VA social security number, maintained in terminal digit order. (b) Automated records are indexed by name, VA file number, payee number and type of vendor.

Safeguards: Physical Security: Access to VA working space and medical record storage areas is restricted to VA employees on a 'need to know' basis. Generally, VA file areas are locked after normal duty hours and are protected from outside access by the Federal Protective Service. Employee file records and file records of public figures or otherwise sensitive medical record files are stored in separate locked files. Strict control measures are enforced to ensure that disclosure is limited to a 'need to know' basis.

Retention and disposal: Medical Records: Individual patient medical records are retained at each health care facility for a minimum of three (3) years after the last episode of care. After the third year of inactivity the paper record is screened, and vital documents are removed and retained at the facility indefinitely, the remaining portion of the record is transferred to the nearest Federal Record Center for twelve (12) more years of storage.

System manager(s) and address: DIRECTOR, MEDICAL ADMINISTRATION SERVICE (136), VA Central Office, Washington, D.C. 20420.

thorized and requested to receive tenders, to make allotments as directed by the Secretary of the Treasury, to issue such notices as may be necessary, to receive payment for and make delivery of securities on full-paid allotments, and to issue interim certificates pending delivery of the definitive securities.

6.2 The Secretary of the Treasury may at any time issue supplemental or amendatory rules and regulations governing the offering. Public announcement of such changes will be promptly provided.

PAUL H. TAYLOR,
Acting Fiscal Assistant Secretary.

[FR Doc 78-2690 Filed 1-27-78; 8:45 am]

[8320-01]

VETERANS ADMINISTRATION

PRIVACY ACT OF 1974

Proposed Amendment of System Notice; Additional Routine Uses

Notice is hereby given that the Veterans Administration is considering adding three new routine use statements to each of the following systems of VA records set forth on pages 49726-49767 of the FEDERAL REGISTER of September 27, 1977.

49VA21 Veterans, Dependents and Beneficiaries Compensation and Pension Records—VA.

50VA22 Veterans, Dependents, Beneficiaries, and Armed Forces Personnel Education and Rehabilitation Records—VA.

58VA21/22 TARGET—Compensation, Pension, Education, and Rehabilitation Records—VA.

The first two routine use statements were previously adopted for the system of records entitled "Patient Medical Records—VA" (24VA136), and the third routine use statement was adopted for the system of records entitled "Veterans and Beneficiary Identification and Records Locator System—VA" (38VA28). Since these routine use statements allow for the release of medical record data, excluding name and address (unless furnished by the requester), for necessary and proper research pruposes to epidemiological and other research facilities and allow for the release of the name(s) and addresses(es) of present or former personnel of the armed services and/or their dependents to Federal agencies for the purpose of conducting, directly or under Federal contract, Government research necessary in order to accomplish a statutory purpose of that agency, the Veterans Administration has determined that, in addition to the "Patient Mecical Records—VA" and "Veterans and Beneficiary Identification and Records Locator System—VA", these routine uses are required in the three additional systems listed above. Release of information for these purposes is considered a necessary and proper use of data in these systems of records and will enable the Veterans Administration to be of maximum assistance in the conduct of authorized medical studies.

Interested persons are invited to submit written comments, suggestions, or objections regarding the proposal to the Administrator of Veterans Affairs (271A), Veterans Administration, 810 Vermont Avenue NW., Washington, D.C. 20420. All relevant material received before March 1, 1978, will be considered. All written comments received will be available for public inspection at the above address only between the hours of 8 a.m. and 4:30 p.m. Monday through Friday (except holidays), during the mentioned 30-day period and for 10 days thereafter. Any person visiting Central Office for the purpose of inspecting any such comments will be received by the Central Office Veterans Services Unit in room 132. Such visitors to any VA field station will be informed that the records are available for inspection only in Central Office and furnished the address and the above room number.

Notice is given that it is proposed to make these routine use statements effective the date of final approval by the Administrator of Veterans Affairs.

Approved: January 23, 1978.

By direction of the Administrator.

RUFUS H. WILSON,
Deputy Administrator.

In the system identified as 49VA21, "Veterans, Dependents and Beneficiaries Compensation and Pension Records—VA", appearing at 42 FR 49753, the following routine use statements are added to read as follows:

System name:

Veterans, Dependents and Beneficiaries Compensation and Pension Records—VA.

* * * * *

Routine uses of records maintained in the system, including categories of users and the purposes of such uses:

* * * * *

㉓ Disclosure of medical record data, excluding name and address (unless name and address is furnished by the requester) for research purposes determined to be necessary and proper, to epidemiological and other research facilities approved by the Chief Medical Director.

㉔ The name(s) and address(es) of present or former personnel of the armed services and/or their dependents may be disclosed to the Department of Health, Education, and Welfare, or agency thereof, or other Federal agency, at the written request of the head of the agency or designee of the head of that agency, for the purpose of conducting government research necessary in order to accomplish a statutory purpose of that agency.

㉕ Inquiry of record by research facilities to obtain data necessary to assist in medical studies on veterans for the Veterans' Administration and other agencies, as approved by the Chief Medical Director, provided that the name of the veteran and other pertinent identifying data is furnished by the requester.

In the system identified as 50VA22 "Veterans, Dependents, Beneficiaries and Armed Forces Personnel Education and Rehabilitation Records—VA", appearing at 42 FR 49754, the following routine use statements are added to read as follows:

System name:

Veterans, Dependents, Beneficiaries and Armed Forces Personnel Education and Rehabilitation Records—VA.

* * * * *

Routine uses of records maintained in the system, including categories of users and the purposes of such uses:

* * * * *

㉚ Disclosure of medical record data, excluding name and address (unless name and address is furnished by the requester) for research purposes determined to be necessary and proper, to epidemiological and other research facilities approved by the Chief Medical Director.

㉛ The name(s) and address(es) of present or former personnel of the armed services and/or their dependents may be disclosed to the Department of Health, Education, and Welfare, or agency thereof, or other Federal agency, at the written request of the head of the agency or designee of the head of that agency, for the purpose of conducting government research necessary in order to accomplish a statutory purpose of that agency.

㉜ Inquiry of record by research facilities to obtain data necessary to assist in medical studies on veterans for the Veterans Administration and other agencies, as approved by the Chief Medical Director, provided that the name of the veteran and other pertinent identifying data is furnished by the requester.

In the system identified as 58VA21/22, "TARGET—Compensation, Pension, Education, and Rehabilitation Records—VA", appearing at 42 FR 49760, the following routine use statements are added to read as follows:

System name:

TARGET—Compensation, Pension, Education, and Rehabilitation Records—VA

* * * * *

Routine uses of records maintained in the system, including categories of users and the purposes of such uses:

* * * * *

㉛ Disclosure of medical record data, excluding name and address (unless name and address is furnished by the requester) for research purposes determined to be necessary and proper, to epidemiological and other research facilities approved by the Chief Medical Director.

㉜ The name(s) and address(es) of present or former personnel of the armed services and/or their dependents may be disclosed to the Department of Health, Education, and Welfare, or agency thereof, or other Federal agency, at the written request of the head of the agency or designee of the head of that agency, for the purpose of conducting government research necessary in order to accomplish a statutory purpose of that agency.

㉝ Inquiry of record by research facilities to obtain data necessary to assist in medical studies on veterans for the Veterans Administration and other agencies, as approved by the Chief Medical Director, provided that the name of the veteran and other pertinent identifying data is furnished by the requester.

* * * * *

[FR Doc. 78-2485 Filed 1-27-78; 8:45 am]

[7035-01]

INTERSTATE COMMERCE COMMISSION

[Notice No. 578]

ASSIGNMENT OF HEARINGS

JANUARY 25, 1978.

Cases assigned for hearing, postponement, cancellation or oral argument appear below and will be published only once. This list contains prospective assignments only and does not include cases previously assigned hearing dates. The hearings will be on the issues as presently reflected in the Official Docket of the Commission. An attempt will be made to publish notices of cancellation of hearings as promptly as possible, but interested parties should take appropriate steps to insure that they are notified of cancellation or postponements of hearings in which they are interested.

[illegible] (Sub 4[illegible]), Chicago & Northwestern Gillett, Oconto County, Wis., and Scott Lake, Iron County, Mich., now assigned February 28, 1978, at Rhinelander, Wis., will be held at the City Council Chambers, City Hall, 135 South Steven Street.

MC 126473 (Sub 30), Harold Dickey Transport, Inc., now assigned March 7, 1978, at Chicago, Ill., will be held in Room 1319, Everett McKinley Dirksen Building, 219 South Dearborn Street.

MC 133689 (Sub 135), Overland Express, Inc., now assigned March 8, 1978, at Chicago, Ill., will be held in Room 1319, Everett McKinley Dirksen Building, 219 South Dearborn Street.

AB10 (Sub 6), Wabash Railroad Co. and Norfolk & Western Railway Co., abandonment between Fairbury and Clay, in Livingston County, Ill., now being assigned April 17, 1978 (1 week), at Pontiac, Ill., in a hearing room to be later designated.

MC 110420 (Sub 771), Quality Carriers, Inc. and MC 124078 (Sub 726), Schwerman Trucking Co., now being assigned April 11, 1978 (1 day), at Chicago, Ill., in a hearing room to be later designated.

MC 110988 (Sub 348), Schneider Truck Lines, Inc., now being assigned April 12, 1978 (1 day), at Chicago, Ill., in a hearing room to be later designated.

MC 141511 (Sub 2), Robert W. Rettig, d.b.a. Protein Express, now being assigned April 13, 1978 (1 day), at Chicago, Ill., in a hearing room to be later designated.

MC 102401 (Sub 23), Taylor Heavy Hauling, Inc., now being assigned April 14, 1978 (1 day), at Chicago, Ill., in a hearing room to be later designated.

MC 119619 (Sub 110), Distributors Service Co., Inc., now assigned March 9, 1978 at Chicago, Ill., will be held in Room 1319, Everett McKinley Dirksen Building, 219 South Dearborn Street.

MC 119789 (Sub 380), Caravan Refrigerated Cargo, Inc., now assigned March 13, 1978, at Chicago, Ill., will be held in Room 1319, Everett McKinley Dirksen Building, 219 South Dearborn Street.

MC 51146 (Sub 501), Schneider Transport, Inc., now assigned March 14, 1978, at Chicago, Ill., will be held at Room 1319, Everett McKinley Dirksen Building, 219 South Dearborn Street.

MC 113678 (Sub 684), Curtis, Inc., now assigned March 16, 1978, at Chicago, Ill., will be held at Room 1319, Everett McKinley Dirksen Building, 219 South Dearborn Street.

MC 115496 (Sub 70), Lumber Transport, Inc., now being assigned January 31, 1978, for prehearing conference at the Offices of the Interstate Commerce Commission in Washington, D.C.

MC 13163, R. C. Van Lines, Inc.—Purchase—Trans-World Movers, Inc., Transport Clearing of Colorado, Inc., Successor in Interest, and MC 128155 (Sub 5), R. C. Van Lines, Inc., now assigned February 13, 1978, at Denver, Colo., will be held in the Courtroom, 1050 17th Street, Suite 1718.

MC 58035 (Sub 13), Trans-Western Express, Ltd., now assigned February 8, 1978, at Denver, Colo., will be held in the Courtroom, 1050 17th Street, Suite 1718.

H. G. HOMME, Jr.,
Acting Secretary.

[7036-01]

FOURTH SECTION APPLICATION FOR RELIEF

JANUARY 25, 1978.

This application for long-and-short-haul relief has been filed with the I.C.C.

Protests are due at the I.C.C. on or before February 14, 1978.

FSA No. 43494, Trans-Continental Freight Bureau, Agent's No. 520, rail rates on champagne, vermouth and wine, from Modesto Colony, Calif., to Elizabeth, N.J., to be published in its tariff 2-0, I.C.C 1947.

Grounds for relief—water competition.

By the Commission.

H. G. HOMME, Jr.,
Acting Secretary.

[FR Doc. 78-2496 Filed 1-27-78; 8:45 am]

[7035-01]

[Notice No. 286]

MOTOR CARRIER TRANSFER PROCEEDINGS

JANUARY 30, 1978.

Application filed for temporary authority under section 210a(b) in connection with transfer application under section 212(b) and Transfer Rules, 49 CFR Part 1132:

No. MC-FC-77514. By application filed January 17, 1978, GEORGE KU, INC., 1480 Mount Jackson Road, New Castle, Pa. 16102, seeks temporary authority to transfer the operating rights of Bessemer Hillsville Bus Co., 310 East Liberty Street, Lowellville, Ohio 44436, under section 210a(b). The transfer to George Ku, Inc., of the operating rights of Bessemer Hillsville Bus Co., is presently pending.

By the Commission.

H. G. HOMME, Jr.,
Acting Secretary.

[FR Doc. 78-2499 Filed 1-27-78; 8:45 am]

[7035-01]

[Notice No. 287]

MOTOR CARRIER TRANSFER PROCEEDINGS

JANUARY 30, 1978.

Application filed for temporary authority under section 210a(b) in connection with transfer application under section 212(b) and Transfer Rules, 49 CFR Part 1132:

No. MC-FC-77515. By application filed January 19, 1978, MICHAEL J. FITZGIBBON, an individual, d.b.a. FITZ FREIGHT TRANSFER, P.O. Box 1144, Miami, Okla. 7435[illegible], seeks temporary authority to transfer the operating rights of Security Bank &

Nov. 18, 1977

Mr. J. C. Peckarsky
Director, Compensation and Pension Service (21)

Deputy ACMD for Research and Development (15A)

1. I attach a letter from Dr. Glyn G. Caldwell of the CDC, dated November 16, and a list of servicemen known to have participated in the nuclear trials at Yucca Flats on August 31, 1957. Dr. Caldwell has asked us to identify any who are known to be dead, and would appreciate any information on the location of the death certificates or other details.

2. As we discussed by telephone, any additional information that you have about these individuals would be very much appreciated. We feel that it is very important to learn as much as possible of the outcome of these nuclear trials.

3. Thank you very much for your cooperation.

LAWRENCE B. HOBSON, M.D., Ph.D.

Attachment

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
ATLANTA, GEORGIA 30333
TELEPHONE (404) 633-3311

November 16, 1977

Lawrence B. Hobson, M.D., Ph.D. (15A)
Veterans Administration Central Office
810 Vermont Avenue, NW
Washington, D.C. 20420

Dear Dr. Hobson:

Enclosed is the list of men with film badges present at Yucca Flats on August 31, 1957, for you to have compared to the V.A. death registry.

I have lined through all the names of men we have already contacted, although there are a couple left in who are known to be dead, but I have no additional information on them. If you are going to run the list in batches, I would like to suggest that the first be the 82nd Provisional Company, 12th Infantry, 3rd Transport Company (Hcptr), 31st Transport Company (Hcptr) and the special projects (50.1, 50.3, 50.8). When you do complete a batch, I would like to know the results rather than waiting for the entire list to be completed.

I have contacted Col. Miller and Col. Nowasinski in the Army Surgeon General's office and Dr. Walter Weyzen of the DOE to urge convening the Chiefs of Medical Services Policy Board as soon as possible. All agreed to do so and feel as we do that there is enough suspicion of an increased incidence to warrant the detailed study.

I await impatiently the results of your death certificate search and our next meeting which will hopefully determine the next steps to take in this investigation.

Sincerely yours,

Glyn G. Caldwell, M.D.

Glyn G. Caldwell, M.D.
Chief, Cancer Branch
Chronic Diseases Division
Bureau of Epidemiology

Enclosure

RECEIVED

NOV 18 1977

11-124 ACMD for R&D

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
NATIONAL INSTITUTES OF HEALTH
BETHESDA, MARYLAND 20014

August 29, 1977

NATIONAL [illegible]

Dr. Philip Schneider
Assoc. Director for Workforce Information
Bureau of Manpower Information Systems
U.S. Civil Service Commission
Washington, D.C. 20415

Dear Dr. Schneider:

With a colleague of mine I am pursuing a study of the possible health effects of multiple immunizations which utilizes information collected on employees of Ft. Detrick, Md. We are attempting to follow the 3000+ civilian personnel who were immunized against biologic agents developed at Ft. Detrick from 1945 through 1969. I have been in contact with Thomas Tinsley of the Bureau of Retirement, Insurance and Occupational Health, and he has agreed to search his files with regard to individuals who have retired from government service or who have died. Could you provide information as to whether the individuals we are attempting to contact are still employed by the federal government, and if so where are they employed? We can provide you with a magnetic tape which carries social security number, date of birth and name of the 1274 persons on whom we need additional information. We can reimburse your office for the costs incurred on this project.

The information which you provide concerning the whereabouts of these individuals will make it possible for us to answer a very important question concerning the possible health effects of multiple immunizations. I would appreciate whatever assistance you can provide in this regard.

Sincerely,

Thomas J. Mason, Ph.D.
Environmental Epidemiology Branch

TJM/gca

note: page 2 of attachment

UNITED STATES CIVIL SERVICE COMMISSION
WASHINGTON, D.C. 20415

IN REPLY PLEASE REFER TO

YOUR REFERENCE

JAN 11 1978

Honorable Richardson Preyer
Chairman
Government Information and Individual
  Rights Subcommittee
Committee on Government Operations
U. S. House of Representatives
Washington, D. C. 20515

Dear Mr. Chairman:

I am pleased to respond to your letter of November 14, 1977, which we received on November 25, 1977, concerning the release of selected data from the Commission's Central Personnel Data File (CPDF) to the Department of Health, Education, and Welfare (HEW) under Project Match. As the key Federal agency with major responsibility for establishing policy on the collection, maintenance and disclosure of personal data on Federal civilian employees, we are extremely sensitive to issues relating to the protection of personal privacy. Therefore, your inquiry provides us with a valuable forum to discuss this particular disclosure and to dispel any concerns you may have. We will respond first to your comments on the HEW disclosure and then address your queries concerning our privacy and security standards covering CPDF as detailed in our August 24 letter to you. A similar response is being provided to Congressman Moss.

I must state from the outset that we do not agree with your conclusions that the Commission failed to comply with its own standards and the Privacy Act concerning the disclosure to HEW. On the contrary, we feel that the disclosure was in accordance with both the Privacy Act and our internal standards, and fully meets the requirements of both.

The enabling legislation creating the Office of Inspector General at HEW (Public Law 94-505, October 15, 1976) establishes the Inspector General's responsibility to detect fraud and abuse against HEW programs and provides the requisite authority to request assistance and information from Federal agencies to meet those responsibilities. In particular the authority to request data from systems of records covered by the Privacy Act is clearly stated in section 205 (b)(3) of the legislation:

Attachment

Requests for Disclosure of Data from CPDF Not Covered by a Routine Use

The following information is provided in response to the request from Congressmen Richardson Preyer and John E. Moss in a November 14, 1977, letter to Chairman Campbell which in part said ". . . what other requests have been made by Federal agencies for personally identifiable information whose disclosure is not covered by a routine use; whether these requests have been fulfilled in whole or in part; and the reasons for your action in each case. Please supply a copy of any letters that were written to agencies discussing these issues."

1. Office of the Inspector General, HEW, in a letter dated October 29, 1977 (copy attached).

   In this letter, the Inspector General, although not asking for disclosure of new data, requested permission to use the data, previously provided under Project Match to match against the Office of Education Student Loan Default file and the Federal Old-Age, Survivors, and Disability Insurance Benefits and Supplemental Security Income files from the Social Security Administration to detect fraud and abuse in these programs. Pursuant to advice of the General Counsel contained in a memorandum of November 14, 1977 (copy attached), the Inspector General was asked to provide separate justification for the proposed modification to the memorandum to include those programs. This information was furnished by HEW in a letter dated December 1, 1977 (copy attached). Subsequently HEW was informed by letter of December 23, 1977 (copy attached), that the Commission could agree to expanded use of the previously furnished data to match against the Office of Education Student Loan Default file. The decision to withhold approval for matching of the data against the Federal Old-Age, Survivors, and Disability Insurance Benefits and Supplemental Security Income files reflects the Commission's deliberate approach to a case-by-case consideration of HEW's requests, an approach also evidenced by the Commission's earlier rejection of HEW's proposal to use the Commission's data for matching against files of recipients of food stamps and unemployment benefits. As additional background, attached are informational copies of the memorandum of understanding between the Commission and HEW of August 18, 1977, and of the memorandum of understanding dated December 8, 1977, signed by Secretary Califano, Attorney General Bell and Chairman Campbell.

2. National Cancer Institute, National Institutes of Health, HEW, in a letter dated August 29, 1977 (copy attached).

   In this letter, Dr. Mason requested current employment location information on former employees of Ft. Detrick, Maryland. The identified employees will be asked to participate in a voluntary study of potential adverse health effects of multiple immunication received during their tenure at Ft. Detrick. The data being supplied (agency and employing office address) is public information as defined in 5 CFR 294.702(a) and will be provided under provision of 5 U.S.C. 552a(b)(2) and (b)(8).

3. Federal Personnel and Compensation Division, GAO, in a letter dated March 31, 1977 (copy attached).

   In this letter, GAO requested cooperation and comments on a proposal to use Commission records to identify whether certain debtors of the U.S. Government are current or former Federal employees. In a response dated May 4, 1977 (copy attached), the Commission's General Counsel suggested that the lack of specific legislation covering a generalized debt-collection scheme in relation to disclosure of records covered by the Privacy Act raised some concerns. No further actions have developed as a result of this exchange of views.

Commission provides that "no use will be made of any records provided by the Commission which do not match HEW benefit files." In other words, only data pertaining to benefit recipients will be translated from computer format (that is solely machine-recognizable) into printed form. Second, and more important, HEW could have achieved its objectives without the Commission's furnishing of the computer records, merely by identifying to the Commission those individuals who are benefit recipients and asking the Commission to supply the public information elements (salary and duty station) needed to detect and investigate possible program abuses. This approach was not adopted due to the computer resource limitations at the Commission to accomplish such a match.

With these concepts in mind, we will briefly discuss each of the several conditions of the Privacy Act which, in our judgement, could serve as legal authorization for the Commission's release of computer records to HEW.

In regard to our choice of release under the Freedom of Information Act (FOIA), we note your point that the Act permits any person to request information pursuant to the Act and that the definition of "person" at 5 U.S.C. 551(2) specifically excludes an agency. Your conclusion, however, that there is no authority for an agency to direct an FOIA request to another agency suggests an interpretation of subsection (b)(2) of the Privacy Act which would render the provision inapplicable except when considering a request for information which invokes the FOIA. It is our view, however, that subsection (b)(2) can come into play upon a determination that disclosure would be required by the FOIA _if_ an FOIA request were being considered. To see an actual FOIA request as a prerequisite for utilizing subsection (b)(2) would have the unfortunate result of prohibiting or delaying release of data to an agency or other recipient even though the data previously had been made public by a person who had been granted access to the data in response to an FOIA request. If subsection (b)(2) is interpreted as the establishment of a standard which permits an agency to disclose information subject to the Privacy Act when the public interest to be served by disclosure outweighs the privacy interest, it becomes clear that the benefit expected to accrue to the public from law enforcement efforts of the Office of Inspector General is substantial enough to warrant the limited disclosure to and use by HEW of the Commission's computer records.

Based on the successful experiences reported by HEW in earlier trial matches, and in light of the limitations on data review imposed by the memorandum of understanding between the Commission and HEW, disclosure of the computer records to HEW can also be found to be within the scope of one of the Commission's routine uses established in accordance with 5 U.S.C. 552a(b)(3). This routine use states that information may be "disclosed to the appropriate Federal, State, or local agency responsible for investigating, prosecuting, enforcing, or implementing a statute, rule, regulation, or order where there is an indication of a violation or potential violation of civil or criminal law or regulations." (See 42 Fed. Reg. 48739 (1977).)

Disclosure under this routine use can be found compatible with the purpose for which the records were collected, in our opinion, by virtue of the provision at 5 CFR 735.101, adopted pursuant to Executive Order 11222: "The maintenance of unusually high standards of honesty, integrity, impartiality, and conduct by Government employees and special Government employees is essential to assure the proper performance of the Government business and the maintenance of confidence by citizens in their Government." Moreover, 5 CFR 735.209 states: "An employee shall not engage in criminal, infamous, dishonest, immoral, or notoriously disgraceful conduct, or other conduct prejudicial to the Government."

5 U.S.C. 552a(b)(7) sanctions disclosure "to another agency or to an instrumentality of any governmental jurisdiction within or under the control of the United States for a civil or criminal law enforcement activity if the activity is authorized by law, and if the head of the agency or instrumentality has made a written request to the agency which maintains the record specifying the particular portion desired and the law enforcement activity for which the record is sought." Although the emphasis of subsection (b)(7) on specificity would appear to place requests for information on a broad category of individuals outside this provision, the terms of the memorandum of understanding between HEW and the Commission effectively limit the class of individuals whose records are available for review to include only those Federal employees who are benefit recipients.

Finally, the legislation creating HEW's Office of Inspector General provides that an agency shall make information "available to the Inspector General in the same manner and to the same extent it would be available to the Comptroller General." This provision, when read in conjunction with 5 U.S.C. 552a(b)(10), which permits disclosure "to the Comptroller General ... in the course of the performance of the duties of the General Accounting Office," indicates that it is permissible under the Privacy Act to furnish records for use by the Inspector General in carrying out his official responsibilities.

While it is true that our initial analysis led to the conclusion that disclosure of the Commission's computer records was appropriate under 5 U.S.C. 552a(b)(2), it should be evident that other conditions set forth in subsection (b) offer legal rationale which can also support disclosure. The ability to mount a legal argument to justify disclosure of Privacy Act records, however, does not diminish our responsibility to ascertain whether the planned uses of records are consonant with Congressional intent. In this regard, the enabling legislation creating the Inspector General's office, as discussed earlier, clearly contemplated disclosure of records to that office from other agencies' Privacy Act systems of records to assist in uncovering HEW program abuses.

With respect to our August 24, 1977, response to your inquiries regarding Commission standards for security of data in the CPDF, we believe that the disclosure to HEW was in accord with those standards. In your letter, you quoted a portion of those standards regarding access to data by other agencies which would imply that release was restricted only to published routine uses. However, please allow us to expand on that portion of the standard by quoting the sentence which preceded it, which stated, "Access to individually identifiable data is restricted as required by the Privacy Act of 1974 or released as required under the Freedom of Information Act (FOIA) as amended."

As discussed previously, disclosure of data to HEW was accomplished under FOIA but, as pointed out, could properly have been accomplished under other provisions of the Privacy Act as well--including the routine use previously cited. Therefore, we feel we have fully complied with the standards set forth in our August 24 correspondence.

We are satisfied, as we hope you are, that our disclosure of computer records to HEW was consistent with legislative intent and, moreover, that the terms of our memorandum of understanding with HEW coupled with HEW's independent Privacy Act responsibilities, afford full protection to the interests of Federal employees. As you requested, the enclosure to this letter provides information on other requests for data by Federal agencies. The information in the enclosure demonstrates the thoughtful, cautious analysis made upon receipt of each request for Commission data, whereby we weigh the facts of each individual case to assure that there is a dominant public interest to be served before we decide to release data about individuals. As pointed out in the enclosure, our approach has resulted in agreement to only two of the five proposals submitted by HEW for use of CPDF records.

We understand that the Office of Management and Budget plans in the near future to issue guidelines on the transfer of records from one agency to another in support of matching projects. We will, of course, refer to such guidelines, once they become available, in deciding how to respond to requests for use of CPDF records in matching projects.

My staff would be glad to discuss further this and other privacy issues with you or your staff. Please do not hesitate to contact me if we can be of further assistance. We are convinced that continued dialogue on the issues confronting agencies regarding privacy is one of the most effective methods available to us to ensure protection of that privacy.

Sincerely yours,

Alan K. Campbell
Chairman

Attachment

RESPONSES TO QUESTIONS CONCERNING ADJUDICATION OF CLAIMS

Answer: The dates and places of service as well as participation in an A-bomb test together with the amount of radiation exposure received is verified through correspondence with the various components of the Department of Defense.

Question: What agency, if any, of the Federal government responds to an inquiry of this nature?

Answer: Primarily, the various components of the Department of Defense. However, when the appropriate military branch is unable to respond, the Department of Energy is called upon to assist in furnishing the necessary information.

Question: If the agency's response does not support the veteran's allegation of being in an area where radiation exposure occurred, what further action is taken by the local (Regional Office) adjudication personnel to validate a continuing assertion that the veteran did serve in an exposed area?

Answer: If the veteran's allegation as to service in an area where radiation exposure occurred cannot be verified by official records, then secondary evidence is acceptable. This secondary evidence should take the form of certified statements from comrades with whom the veteran served who can testify from their own knowledge that the veteran did, in fact, serve in a radiation exposure area.

Question: What agency, if any, validates radiation exposure if the veteran's presence in a contaminated area has been affirmed?

Answer: The branch of service in which the veteran served is the primary source for validation of radiation exposure. In the event the military branch in which the veteran served does not have the information, the Department of Energy may be contacted.

Question: How do regional office adjudication personnel determine, when appropriate, levels of exposure suffered by individual veterans?

Answer: There is no method available to regional office adjudication personnel for determining levels of exposure suffered by individuals. The levels of exposure are obtained from the various components of the Department of Defense.

Question: Are dosimeter readings as to amount of radiation exposure pertaining to individual veterans readily available from any Federal agency? If so, identify the Federal agency.

Answer: Dosimeter readings are available through the various components of the Department of Defense or the Department of Energy.

Question: What specific directives have been issued by VA Central Office to VA Regional Office adjudication personnel to assist in developing claims alleging disabilities due to radiation exposure? Please identify such directives by title and date of issue.

Answer: There is no specific directive for development of claims for disease or injury from radiation. The untoward results of radiation exposure is developed in the same manner as other injury or disease processes. Adjudication personnel are aware that in claims where information is not readily available or difficult to obtain that the assistance of VA Central Office is available.

On May 31, 1977, Veterans Administration Area Field Directors were informed to notify their regional offices that all claims received regarding a current disease or injury related to radiation exposure while participating in Atomic Bomb tests are to be reported to VA Central Office by telephone for assistance in development for participation and dosimetry records.

Further, our Adjudication Procedures Manual M21-1 contains instructions that an extra copy of the rating decision will be prepared in claims in which injury from ionizing radiation is shown or claimed and forwarded to VA Central Office. These decisions are very carefully reviewed. Occasionally, claims folders are called into this office for independent review and referral to the Chief Medical Director for opinion when the situation warrants.

Mr. ROGERS. Thank you for your patience. The committee stands adjourned, subject to the call of the chair.

[Whereupon, at 6:10 p.m. the committee adjourned, subject to the call of the Chair.]

EFFECT OF RADIATION ON HUMAN HEALTH

Health Effects of Ionizing Radiation

TUESDAY, FEBRUARY 28, 1978

House of Representatives,
Subcommittee on Health and the Environment,
Committee on Interstate and Foreign Commerce,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10 a.m., in room 2322, Rayburn House Office Building, Hon. Paul G. Rogers, chairman, presiding.

Mr. Rogers. The subcommittee will come to order.

The purpose of today's hearing is to assemble for the record the facts concerning a report which indicates that workers at the Portsmouth Naval Shipyard have a death rate from cancer of over twice the national average.

I might say, we are having a joint session, one with a Senate representative from the Senate Health Committee as well as the House Subcommittee on Health and the Environment.

Now, while the report bears directly on the more than 6,000 employees at the Portsmouth yard, it also affects thousands of workers at eight other shipyards at locations around the country who are also involved in the construction and maintenance of nuclear submarines.

The report in question was compiled by Dr. Thomas Najarian, a hematology fellow at the Veterans Administration Hospital in Boston, Prof. Theodore Colton, a professor of biostatistics at Dartmouth Medical School, and staff members of the Boston Globe. Government agencies have not yet had an opportunity to examine this report as it has only been recently concluded. However, it is my understanding that it has been submitted for publication to a scientific journal.

The implications of the report's conclusions are so vast, so far-reaching and so alarming that I feel that it is incumbent upon us to insure that an immediate followup study is undertaken. I have written to Secretary Califano asking that such a study be initiated, and I agree with Senator McIntyre who has expressed his concerrn that an independent group conduct this followup as well. The National Institute of Occupational Health and Safety, under the direction of the Center for Disease Control has made preliminary plans to do so, but I have been advised that the Department of the Navy has not yet signed off on this request, and that in addition, Secretary Claytor of the Department of the Navy in correspondence with Secretary Califano of the Department of HEW has suggested that HEW delay the initiation of this study. This apparent move to delay a prompt followup would concern me, and we will pursue this with the appropriate naval officials.

During earlier hearings on the effects of low-level radiation on human health we faced the situation with respect to the Department of Defense, the Department of Energy, and the Veterans' Administration, where because of those agencies' involvement with the nuclear tests in question the committee felt that an outside agency would be better qualified to conduct a study of the personnel involved in those tests. The same principle holds in this situation. There could not help but be an apparent conflict of interest if the Navy or the Department of Energy were to investigate the safety of the shipyards which operate under their jurisdiction and with their sanction.

Finally, we have once again a situation where the management agency finds no violation of the existing radiation safety levels, but where outside experts point to an apparent pattern of adverse health effects associated with exposure at these levels, leaving us with no choice but to question the adequacy of existing radiation safety standards.

I think Dr. Carter has a statement.

Mr. CARTER. Thank you, Mr. Chairman, I am pleased to join you in holding this hearing on the possibility of radiation-induced illness and health and death among nuclear workers at our Nation's naval shipyards.

The reports we have heard on the mortality experience of certain workers at the Portsmouth Naval Shipyard are indeed cause for concern. According to the Boston Globe survey, employees at the Portsmouth Naval Shipyard who were exposed to radiation, have a cancer death rate more than twice the national average, and nearly 80 percent higher than the rate for other shipyard workers who did not do nuclear work.

While we should recognize that this study is only a preliminary one, I believe the findings warrant further investigation by an independent agency. Moreover, in light of the other evidence presented to this subcommittee on the health risk of low-level radiation, I believe we have an important responsibility to the workers at naval shipyards to give this situation a full hearing.

I take pride in being a strong supporter of our Nation's defense system, and I believe that operation and maintenance of our nuclear fleet—especially our nuclear submarines—is indeed vital to our country's defense. I have had the pleasure of knowing Admiral Rickover for many years, and I welcome him to our hearing today.

Finally, I would like to take this opportunity to commend our distinguished colleague, Senator Thomas McIntyre, for taking the lead in alerting the subcommittee and the administration to this problem, and for coming to speak with us today.

Thank you, Mr. Chairman.

Mr. ROGERS. Thank you.

We want to welcome Senator Hathaway, a representative of the Senate Human Resources Committee, and our first witness today, Senator McIntyre, who, as my colleague stated, alerted the subcommittee to this problem, and way back in December of last year brought this to the attention of the Secretary and the attention of the Congress and the public. So, we commend you and appreciate the fine cooperation this committee has had from you and your staff. Mr. Dooley has been most helpful, too, Senator, to the committee.

So, we are delighted to welcome you and will be pleased to have you give your thinking to the committee for our guidance.

STATEMENT OF HON. THOMAS J. McINTYRE, A U.S. SENATOR FROM THE STATE OF NEW HAMPSHIRE

Senator McIntyre. Thank you, Mr. Chairman, Dr. Carter, and members of this subcommittee, Senator Hathaway who, I believe, represents the Health Committee of the Senate. I want to thank you for the timely scheduling of this hearing on a matter of grave importance to nuclear workers at shipyards across the nation.

From discussions with Chairman Rogers, I know the subcommittee fully understands the need for a professional, indepth, and independent investigation into whether shipyard workers are suffering from leukemia and other cancers caused by radiation exposure.

This subcommittee has a well-earned reputation for diligence on problems affecting the health of our citizens. Your recent hearings on potential medical risks from exposures at U.S. nuclear weapons tests conducted more than 20 years ago spurred the Pentagon and health agencies into a full-scale search for individuals who may require medical treatment.

You have been fair-minded and realistic about that problem, so I know that nothing will prevent the subcommittee from investigating every pertinent fact about possible radiation-caused disease in connection with the Navy's nuclear program.

I make these points at the outset, Mr. Chairman and members of the committee because there are fears expressed by some that the Government, and I would guess that includes the Congress, cannot be relied upon to investigate this problem. It has been suggested the Pentagon is trying to stonewall the investigation.

The front page of the Portsmouth, N.H., Herald carried a headline only last Friday which declared:

"DOD Bars Shipyard Gates to Inspection by HEW Team." The first paragraph of that news story was as follows:

> They shall not pass seems to be the attitude of the Defense Department in Washington to getting a government health team "aboard" the Portsmouth Naval Shipyard to study possible effects of radiation on nuclear workers.

Now, I know that the Navy has finally relented, that it will allow the Center for Disease Control to study the health histories of shipyard workers. But the situation remains murky. The restrictions are not clear and I am sure the subcommittee will want to hear today precisely how cooperatinve the Navy intends to be.

Let me state an additional reason why I believe this hearing is so important. You know that as Members of the Congress we share responsibility with the President for assuring the security of our national defense. I serve on the Armed Services Committee of the U.S. Senate.

Now, this is not the forum for discussion of strategic doctrine, but it is a plain and simple fact that nuclear missile submarines play a major role in deterring nuclear attack. Because they are virtually invulnerable, America's nuclear submarines provide assurance of devastating retaliation.

Our undersea nuclear force can survive any conceivable attack and still destroy the attacker's homeland. And, it should be clearly understood that America's security will rely incresingly on our nuclear force at sea.

This concept is very important if we are to achieve the stability that assures world peace. Now, I say that if nuclear warships are vital to our national security—and they are—then the crews which man those ships and the shipyards which build and service those vessels are also vital to our national security.

And the most important element in assuring the continued efficiency of these vital shipyards are the many skilled and dedicated workers whose efforts contribute in a major way to assuring world peace.

We owe them much, Mr. Chairman, and I know you and I would deeply resent any implication that our Government does not take every step possible to assure the health and safety of those shipyard workers.

For all those reasons, I was quite concerned to learn on December 8 of last year that Dr. Thomas Najarian, a hematology fellow at Boston Veterans Hospital, suspected a high incidence of cancer among nuclear workers at Portsmouth Naval Shipyard.

On December 9 of last year I wrote to Rear Adm. Gus Kinear to request a Navy review of the allegations. And, my telephone soon began ringing with calls from reporters about worker concerns at some of the eight other shipyards that do nuclear submarine overhauls.

In response, Mr. Chairman, to my request for a Navy review, my staff met on December 14 with Mr. Murray Miles, the top civilian aide to Adm. Hyman Rickover, and Dr. J. C. Rivera, Director, Undersea Medicine, Navy Bureau of Medicine and Surgery.

Their assurances were similar to those of Portsmouth Commander, Capt. William McDonough. They all agreed that there was no problem at the shipyard.

Moreover, Captain McDonough released a statement cleared by the Pentagon which cited the Department of Energy's long-range health studies of personnel radiation exposure. The statement further said:

> In addition, the Navy has made studies of health records, and has other studies currently in progress. Records of 56,000 personnel have been analyzed. these analyses show no person has developed any illness caused by radiation from a Navy nuclear propulsion plant. These studies also show the incidence of various diseases—including cancer and leukemia—was lower for those personnel than for the general public

However, Mr. Miles confirmed to my staff in response to questions that the records of 56,000 personnel relate to uniformed personnel—not civilian shipyard workers. He further stated the Navy did not want to do a followup study of past and present shipyard workers to determine if there is a link between shipyard radiation work and illnesses such as leukemia.

Now, in fairness to Mr. Miles, he suggested the Navy should not do the study because its findings would not be considered impartial. He and Dr. Rivera agreed that the proper course would be for

Dr. Najarian to ask the Veterans' Administration to sponsor a health study.

But Dr. Najarian reported to my staff that he had already tried to get sanction for such a study and that his request was turned aside.

Given this background—and the fact that I was distressed by apparent gaps in the Navy's research—I concurred with suggestions from Chairman Rogers' staff that the proper agency for an independent study was the Center for Disease Control.

So, on January 2 of this year, I wrote to Dr. Julius Richmond, Assistant Secretary of Health, to express my preference for a CDC study. About 1 month later, on February 8, after repeatred efforts by my staff to get confirmation that the study woud be undertaken, I wrote Chairman Rogers of my feelings that the appropriate Government health officials should be called before this subcommittee to determine the best method of coordinating the CDC study I had requested, and the Smokey A-bomb blast study reuested by this subcommittee.

In addition, I cautioned that the Navy has no special program to follow up the health histories of nuclear workers who retire or move to other jobs. This could have a special relevance for men employed in the early days of the nuclear program when, some suggest, that radiation restrictions were not as stringent as they are today.

In my letter to Chairman Rogers I also suggested the need for a national depository of radiation exposure histories. This would guard against the possibility a nuclear worker employed at more than one shipyard, or other nuclear-related jobs, would unwittingly receive an excessive radiation exposure. The comments of the witnesses today might well prove the need for such a depository.

And finally I told the chairman of this subcommittee that the Boston Globe has asked the Navy's comment on its study which indicated a much higher cancer death rate among men exposed to radiation at the shipyard. I recommended that Dr. Najarian be called for testimony along with Government health officials and that the subcommittee inquire about the adequacy of the Navy research efforts when the subcommittee heard additional testimony on February 14 from Pentagon officials.

For the record, I should point out that Dr. Najarian was working with Dr. Thedore Colton, a professor of biostatistics at Dartmouth Medical School, Hanover, N.H., in the preparation of an indepth technical analysis on the incidence of cancer among Porstmouth shipyard workers. Dr. Najarian will testify later and Professor Colton told my office yesterday that a commitment to an overseas trip prevents him from being here this morning.

Now, the situation since February 14 is well known to the subcommittee. The Boston Globe reported on February 19 that its study shows an alarming rate of cancer at the shipyard. I contacted Secretary Califano and he told me by telephone on February 21 that a CDC team would be sent to the shipyard. I wrote Navy Secretary Claytor on February 21 to ask Navy's cooperation with CDC.

But since that time the CDC has not been granted access to shipyard records. I contacted Defense Secretary Harold Brown and

Secretary Claytor by telephone on February 23 to urge that CDC be given Navy cooperation in its investigation.

On Friday, Secretary Claytor wrote me and Secretary Califano. I have sent copies of the letters to Chairman Rogers for distribution to the subcommittee, and I ask unanimous consent they be made a part of the record at this point.

Mr. ROGERS. Without objection, it is so ordered.

[The letters referred to follow:]

DEPARTMENT OF THE NAVY
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20350

February 24, 1978

The Honorable Thomas J. McIntyre
Russell Senate Office Building
Room 105
Washington, D.C. 20510

Dear Senator McIntyre:

I am in receipt of your letter of February 21, 1978, which discusses a study of health histories of past and present shipyard workers.

I am enclosing a copy of a letter I have addressed to Health, Education and Welfare Secretary Joseph A. Califano, in which I have offered Navy cooperation in the efforts of his agency in the study of Portsmouth Naval Shipyard.

The Navy will keep you informed of the progress of the study which will be conducted by an independent agency through the Department of Energy.

Sincerely,

Graham Claytor

W. Graham Claytor, Jr.
Secretary of the Navy

DEPARTMENT OF THE NAVY
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20350

February 24, 1978

The Honorable Joseph A. Califano
Secretary of Health, Education and Welfare
200 Independence Avenue, S.W.
Washington, D.C. 20201

Dear Mr. Secretary:

I am in receipt of a copy of a letter addressed to you by Senator Thomas J. McIntyre, dated February 21, 1978, which discusses a study to be accomplished at Portsmouth Naval Shipyard by the Center for Disease Control.

The Navy has, since December 1977, been negotiating with the Department of Energy to have initiated a study by a competent and independent agency of records of Portsmouth Naval Shipyard workers. I anticipate that these arrangements will be finalized shortly.

The Navy will cooperate with CDC by providing to them the same records at Portsmouth as are provided to the independent agency selected. I would suggest that your efforts in this regard await commencement of activities at Portsmouth by that agency in interests of avoiding duplication or confusion. I would further request that you provide me with the name of an individual who can serve as the contact point with the selected agency.

Sincerely,

W. Graham Claytor

W. Graham Claytor, Jr.
Secretary of the Navy

Senator MCINTYRE. It is encouraging that Secretary Claytor has agreed at last to cooperate. But I would like to point out to the subcommittee—and for the benefit of CDC Director William Foege—that the agreement to cooperate is quite limited.

The subcommittee will note that Secretary Claytor stated that the Navy will cooperate by providing to CDC the same records at Portsmouth as are provided to the independent agency selected by the Department of Energy to do its study.

Secretary Claytor further said that:

> I would suggest that your efforts in this regard await commencement of activities at Portsmouth by that agency in the interests of avoiding duplication or confusion.

I am concerned, Mr. Chairman and members of the subcommittee, about this restriction; not only will it result in unnecessary delay, but also because it will not result in a truly independent study if the CDC is limited to records provided to the Department of Energy.

So, I am sure the subcommittee will want to question the Pentagon witnesses carefully about these restrictions. I am told the CDC team has full security clearances, and that it is ready to begin its work. In addition Secretary Califano has asked for a progress report by March 3.

In conclusion, Mr. Chairman, I feel I must warn the subcommittee that there are growing suspicions the Pentagon is trying to stonewall efforts by CDC to determine if there is a problem at the shipyards.

My New Hampshire colleague—who will testify later—John Durkin, has even written President Carter to ask appointment of scientific and medical experts to monitor, coordinate and review the CDC's investigation.

In this climate of suspicion and distrust the Pentagon has a clear obligation to cooperate, to stop obstructing the CDC and to start being candid with shipyard workers, the Congress, and the American people.

We must have a no-holds barred investigation to assure past and present nuclear shipyard workers that this Government will not shrink from its responsibility to their health and safety.

I know I speak for the workers themselves when I thank the subcommittee for its assistance. The workers are dedicated professionals. They are not panicked by the reports of a health problem. They and their families simply want to know that every effort is being made to assure they work in a healthy and a safe environment.

Thank you very much, Mr. Chairman, and members of the committee.

Mr. ROGERS. Thank you, Senator McIntyre, for a very helpful statement, laying the foundation for the points that need to be gone into by this subcommittee. I assure you, this committee will follow up carefully some of the suggestions you have made, with other witnesses.

We, too, have seen this pattern develop elsewhere, and I think your fears are justified by what has happened to date. So, we will go into this matter thoroughly and will be glad to keep in touch with you and receive any information and suggestions you think would be helpful.

Senator McIntyre. Thank you, Mr. Chairman.

Mr. Rogers. Are there any questions?

Senator Hathaway. Well, Mr. Chairman, I wanted to commend Senator McIntyre for his efforts in this regard. Let me ask you one question, Senator, would you conclude from what you have found so far that we ought to have an independent study, independent even of the CDC, contracted out to a nongovernmental agency?

Senator McIntyre. Senator, if I understand your question, I am very proud of the Portsmouth Shipyard, as you are. I am proud of the whole experience I have had with it up there. I want in every way to make sure that nothing is wrong, but we have this suspicion, this presumption—and I believe it is the obligation of our Government, Senator, to take care of this. I would think that we have the capability, as I said, not to shrink from whatever we do find; to correct any mistakes we have been making, if we have been making any mistakes. I think it is very iffy, whether we have, or not. But the shipyard workers have to have that assurance. I would wonder if I was working there, and I am sure you would wonder, too.

Senator Hathaway. Thank you.

Mr. Rogers. Dr. Carter?

Mr. Carter. Thank you, Mr. Chairman.

Was Portsmouth the first site for refitting nuclear subs?

Senator McIntyre. Was the first——

Mr. Carter. The first site?

Senator McIntyre. Well, we started, I think, in refitting as early as 1959, 1958-59. As a matter of fact, that is what we do today exclusively. We no longer at Portsmouth build new ships, we are, we think, one great repair overhaul yard with a great record.

Mr. Carter. I think you have a great shipyard, too. Portsmouth was where our first nuclear ship, the *Nautilus,* was refitted. Is that not true?

Senator McIntyre. That is correct.

Mr. Carter. Was there an accident reported relative to the refitting of the *Nautilus?*

Senator McIntyre. There are reports that an accident of some form took place, and subsequent witnesses will be able to clarify that. Whether any official record was made of it, or just how severe that accident was, I cannot answer authoritatively but there are press reports of a slip of some kind.

Mr. Carter. According to the article I read, sir, six men were sprayed by water which came from a broken hose near the reactor, and four of those six are now dead of cancer—two or three of leukemia.

I want to thank you for your leadership in this investigation, sir, and I certainly think that the Center for Disease Control in Atlanta is capable of doing this study. It is an independent group, as we know.

Mr. Markey. Mr. Chairman?

Mr. Rogers. Mr. Markey.

Mr. Markey. Senator, you ought to be commended for your longstanding interest in this problem. What I am wondering is, whether or not in your correspondence with the Department of Energy or with the Navy—which has been going on for some time—whether they ever offered to share their studies with you and your office for your own analysis and determination as to the situation which does exist at the shipyard. Have they ever forwarded those to you?

Senator McINTYRE. Well, I have no recollection of any correspondence. I do not know if we would have insisted upon sharing the report itself, except the conclusions. I am certain that they would. The Navy has always cooperated 200 percent with Tom McIntyre. But they do get their back up. I know. I know from my work in conference with your distinguished colleagues, the conference with the members of the House Armed Services Committee that when we are talking about the General Accounting Office maybe taking a look at something, why, the backs of men like Mendel Rivers—now departed—or my friend Congress Hébert would bristle. But I have always found the Navy to be cooperative. In this particular case I do not know whether we asked to share the indicia. I would have hoped and I know that we would have gotten the conclusions, or the result of any study they undertook.

Mr. MARKEY. Thank you, sir.

Mr. ROGERS. Mr. Walgren?

Mr. WALGREN. No questions, Mr. Chairman.

Mr. ROGERS. Senator, thank you so much. The committee will keep in touch with you.

Senator McINTYRE. Thank you, Mr. Chairman.

Mr. ROGERS. Thank you for your presence.

We are pleased to have another colleague from the Senate, the distinguished Senator from New Hampshire, Hon. John A. Durkin.

Senator Durkin, we welcome you to the committee, we know of your strong interest in this matter, and the subcommittee is very anxious to have you give us your thinking and any suggestions that you may have as to what needs to be done. We welcome you.

STATEMENT OF HON. JOHN A. DURKIN, A U.S. SENATOR FROM THE STATE OF NEW HAMPSHIRE

Senator DURKIN. Thank you, Mr. Chairman, I do appreciate the opportunity to testify before you and Senator Hathaway, and the members of your committee. The issues we have to consider are of great importance to the Nation. I think we all realize nuclear submarines are essential to our national security, and so are facilities to outfit and repair them. But while, especially in light of SALT II, the discussions surrounding SALT II with the question of whether our land-based missiles may become more vulnerable to the bigger and more accurate Russian missiles.

But, while there is no question that these facilities are needed, neither can there be any question that the workers have the right to know the risks involved, and to be protected from them to the maximum extent possible.

This issue has arisen, as you know, in connection with the Portsmouth Naval Shipyard. But let there be no question, this is a national problem. There are nine yards across the country, and a great number of congressional districts, and a great number of Senators concerned with this problem.

These submarines are also worked on, as you know, at eight other locations, and what is a problem at Portsmouth is almost certainly a problem at the other sites as well. Those are the naval shipyards at Norfolk, Puget Sound, Charleston, S.C., Mare Island, Pearl Harbor, private yards at Groton, Newport News, and Pascogoula, Miss.

I am pleased that the Center for Disease Control has decided to investigate the possibility that low-level radiation has led to a disturbing increase in the number of deaths from cancer.

My distinguished colleague from New Hampshire, Tom McIntyre, I think deserves our praise for his efforts to begin this investigation. He, Senator Hathaway, and Representative D'Amours have all done an excellent job in responding to this very real problem.

But it is essential that the Center for Disease Control have the cooperation and all the cooperation it needs for this study. The Navy and the Department of Energy should provide whatever records the CDC believes it needs, and should be called upon to do so immediately.

We have had disquieting allegations coming out of the Boston situation that the CDC·has been rebuffed. I am pleased that Secretary of the Navy Claytor has said that they will cooperate, but I have some concerns with the tenor, the text of this letter I will touch upon in a minute or so.

The CDC, as the agency with the most experience in studying health threats, is clearly the most appropriate agency to carry out the investigation. But it is a part of the Government, and that fact has led to suspicion among many of the workers at the Portsmouth Naval Shipyard, with whom Senator Hathaway and I met just last Friday.

Over the weekend I wrote to President Carter, pointing out the concerns of the workers and urging him to appoint a blue-ribbon panel—and I stress—of independent scientific and medical experts to monitor and review the work of the CDC. To coordinate, to review and monitor, and to make recommendations. I include a copy of this letter with my statement and ask it be printed in the record. [See p. 1221.]

Mr. ROGERS. Without objection, it is so orderd.

Senator DURKIN. I suggested to the President three experts whose work I have favorably noted as a member of the Senate Energy Committee, although I am sure there are others. Those were Dr. Karl Z. Morgan, the Neely professor at the School of Nuclear Engineering at Georgia Tech, and a pioneer in health physics; Dr. Irwin Bross of the Roswell Park Memorial Institute in Buffalo, who has analyzed similar date in the past; and Dr. Thomas Mancuso, a research professor at the Graduate School of Public Health at the University of Pittsburgh, who has worked extensively on radiation effects on Government employees.

The concerns of the workers can be easily understood when the history of government and research into low-level radiation is considered.

Although questions about the effect of low-level radiation on workers in nuclear shipyards are relatively new, the possible harmful effects on other Government workers have been suspected for several years.

The Department of Energy, which should be in the forefront of efforts to ascertain whether low-level radiation poses a danger to health, has unfortunately failed to pursue the information.

On at least two occasions, officials of the Department of Energy took actions which suggested a desire to suppress the needed research. I wrote to Secretary Schlesinger a month ago, giving details of the cases and asking him to begin an investigation of his own Department's actions. He has not responded to the letter; and I ask that a copy of that letter be included as well. [See p. 1224.]

Mr. ROGERS. Without objection, so ordered.

Senator DURKIN. This history raises serious questions about the impartiality of the Department of Energy. While they should be called upon to provide whatever information they have, the Department of Energy officials should not—and I stress, should not play a role in conducting the investigation and monitoring the material, and making the recommendations.

I hope the President will act quickly to appoint a blue-ribbon panel to monitor the CDC investigation. Because of the questionable previous actions of the Department of Energy officials, I have, as I said, urged that they not be allowed to play a role in the selection of the panel as well. I think that is very important.

From the letter that I added to the statement you can see what has happened with respect to the tristate leukemia survey which was conducted by Dr. Thomas Mancuso. For some reason or other DOE cut off his funds. The experience of Sister Rosalie Bertell also adds to my dismay. Dr. Bertell's funding was recently cut off by the National Cancer Institute of HEW.

I think the actions of the Department of Energy should be the subject of a separate investigation, and I hope that will proceed as well. But I cannot stress strongly enough that the Department of Energy should not be able to dominate this study.

I am concerned with Secretary Claytor's letter where he says he will give to the CDC the same information that he will give to the independent study. Senator Hathaway and I were at the shipyard on Friday. The shipyard commander rather surprisingly agreed that his recommendation would be an independent study, but then offered that the independent study be done by people recommended by the Department of Energy.

We have heard disquieting rumors that the Department of Energy would be tempted to use the same heavy hand it did with Dr. Mancuso and Sister Bertell; and as I say, I cannot stress strongly enough the Department of Energy should not be able to dominate, and we should not have bureaucrats investigating bureaucrats; we should not have politicians investigating politicians. What we need is an independent scientific medical and expert panel that will conduct, as my colleague Senator McIntyre said, a no-holds-barred investigation and get these answers just as soon as is possible.

I might add that Senator Hollings and Senator Inouye have also written the President, asking him to appoint such a blue-ribbon panel. I have talked to most of the other Senators involved in those States, I sent them a copy of the letter I sent to the President; and I suspect it will have many more Senators joining in the request to the President.

But, I think this is important, if the President chooses not to establish such a panel, I think it is incumbent upon this committee, it is incumbent upon the Congress, it is incumbent upon the House and Senate—and I will propose legislation to establish such a group, requiring to review all the evidence, determine what the health dangers are of low-level radiation.

Mr. Chairman, I do not think we can do anything less than meet our responsibilities, meet our oath of office. I think the CDC is particularly adapted to conduct investigations, but I think it is absoultely essential that there be that panel of independent scientific and medical experts to monitor, to coordinate, to review, and make the recommendation, so that we can—if steps have to be taken—we can take those steps based on scientific fact and not on a political consideration or political rhetoric. I am concerned, as I said, that the Navy seems to want the Department of Energy bureaucrats to investigate them. As I say, we do not want bureaucrats investigating bureaucrats, it has to be a scientific panel.

Thank you, Mr. Chairman.

[Testimony resumes on p. 1229.]

[The attachments to Senator Durkin's prepared statement follow:]

HENRY M. JACKSON, WASH., CHAIRMAN
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W. O. CRAFT, JR., MINORITY COUNSEL

United States Senate
COMMITTEE ON
ENERGY AND NATURAL RESOURCES
WASHINGTON, D.C. 20510

February 25, 1978

President Jimmy Carter
The White House
Washington, D.C. 20500

Dear Mr. President:

Thousands of workers repair and overhaul nuclear boats at nine facilities around the country. This work must be carried out because the nuclear Navy is a vital part of our national defense, one that will become even more important in light of SALT II.

For several years there have been disquieting allegations that the workers at those facilities were exposed to an increased cancer risk, despite official assurances that the workers' exposure to radiation was well within safe limits.

This has become a major concern to workers at the Portsmouth Naval Shipyard following publication of a report in the Boston Sunday Globe by the newspaper's Pulitzer Prize-winning Spotlight Team. A copy of the Globe article is enclosed.

The Globe, operating with admittedly incomplete records, concluded that exposure to low-level radiation, even in small amounts, leads to an alarmingly high incidence of cancer and leukemia. It found that while only 18 percent of the general population dies of cancer, 38.4 percent of the Portsmouth workers who work on nuclear boats die of the disease.

This has been a concern of mine for some time. Last month I wrote to Secretary Schlesinger expressing my strong concern that the Department of Energy appeared to have played an inappropriate role in stifling two research projects, perhaps because the researchers thought the evidence indicated a positive relationship between exposure to low-level radiation and cancer.

I am enclosing a copy of that letter for your perusal. Secretary Schlesinger has not yet responded to it.

A complete independent study of the hazards of working at the facilities where nuclear boats are repaired is clearly required. This is a national problem, and that is why I am seeking your personal involvement.

Such a study should carefully examine the health records of those who have worked at nuclear shipyards, not just at Portsmouth but at the other eight yards -- the Naval yards at Norfolk, Puget Sound, Charleston, Mare Island and Pearl Harbor, and the private shipyards at Groton, Conn., Newport News, Va. and Pascagoula, Miss. The study should attempt to learn whether there is a higher incidence of cancer among such workers and, if so, what action is needed to correct the situation.

There can be no question that facilities to outfit and repair nuclear boats are necessary for our national defense, but neither can there be any question that the workers have a right to know the risks involved and to be protected to the maximum extent possible.

Senator Hathaway and I met with representatives of many of the workers and the shipyard commander at the Portsmouth Naval Shipyard Friday.

The workers asked that a blue ribbon panel of independent scientific and medical experts be appointed to assure the integrity of such a study. I agree a totally independent study is necessary. The previous actions of the Department of Energy, which are certainly open to question, indicate it should not be involved in the selection of the experts.

I therefore urge you to personally appoint a group of independent scientific and medical experts to monitor, coordinate and review the work of the Center for Disease Control, which has already begun a preliminary investigation. The panel of experts should see that all questions are thoroughly reviewed and adequately answered.

There are several experts whose work I have favorably noted as a member of the Energy Committee, and who I commend for your consideration.

These include Dr. Karl Z. Morgan, the Neely Professor at the School of Nuclear Engineering at the Georgia Institute of Technology and a pioneer in health physics; Dr. Irwin Bross of the Roswell Park Memorial Institute in Buffalo, N.Y., who has analyzed similar data in the past; and Dr. Thomas Mancuso, a research professor at the Graduate School of Public Health at the University of Pittsburgh who has worked extensively on radiation effects on government employes.

I respectfully urge you to appoint as soon as possible such a panel of independent scientific and medical experts, so the study can be conducted as expeditiously as possible, and direct the Department of Defense and the Department of the Navy to cooperate fully with the CDC and the panel of experts.

Sincerely,

John A. Durkin

JAD/fn

Enclosures

United States Senate
COMMITTEE ON
ENERGY AND NATURAL RESOURCES
WASHINGTON, D.C. 20510

January 27, 1978

The Honorable James R. Schlesinger
Secretary
Department of Energy
The White House
Washington, D.C. 20500

Dear Mr. Secretary:

I am deeply concerned that actions by your department appear to have had the effect of discouraging research into the health effects of low-level radiation. I hope you will commence a prompt investigation into the role of your department in apparent efforts to terminate funding for scientists whose work has indicated such radiation could be a cause of cancer.

The Tri-State Leukemia survey, which covered persons in New York, Minnesota and Maryland, and research conducted by Dr. Thomas Mancuso at the University of Pittsburgh, have indicated that cancer may be caused by exposure to low-level radiation.

This research is of major importance to the country, because many workers, both in New Hampshire and in other parts of the country, are exposed to such radiation at their jobs. I am sure you will agree that this vital research must be promoted and encouraged.

Yet your department has taken actions which suggest a desire to suppress this research because it raises serious questions about government standards for exposure to low-level radiation.

Dr. Mancuso's work, "A Study of the Lifetime Health and Mortality Experience of ERDA Contractors," has been conducted since 1964 with financial support from the Atomic Energy Commission and the Energy Research and Development Administration. This is an important project because the large data base, 140,000 workers, and the time span of more than 30 years allows the discovery of cancers which take many years to develop.

He has found an unexpected increase in the number of cancer cases among workers, indicating low-level radiation can cause cancer.

Yet, DOE has cut off his funds, giving conflicting reasons for doing so. At one point the decision was attributed to his "imminent retirement," although neither he nor the University of Pittsburgh knew of any retirement plans.

The experience of Sister Rosalie Bertell, Ph.D., adds to my dismay by suggesting a pattern of DOE interference with these essential independent studies. Dr. Bertell, using data from the Tri-State Survey, concluded in published professional papers that exposure to low-level radiation appears to increase the incidence of leukemia.

Dr. Bertell's funding was recently cut off by the National Cancer Institute after unsigned critiques of her work were circulated, apparently by Dr. James Liverman, the acting assistant secretary for environment at DOE. Dr. Liverman did not see fit to send copies of the critiques to Dr. Bertell, although they challenge her professional competence.

Dr. Liverman was also the official who relied on the phantom retirement plans of Dr. Mancuso to stop his research, a fact which raises questions about his commitment to learning the true dangers of low-level radiation.

I urge you to immediately begin an investigation of the role of DOE officials, both in efforts to discredit Dr. Bertell and in canceling the funding for Dr. Mancuso's research.

I believe the DOE and other government agencies should be stepping up their funding of this important research into a problem that may affect millions of Americans, not trying to block inquiries into this important area about which we know far too little.

The basic need to ensure complete scientific freedom, as well as the requirement that workers know of the dangers they face in dealing with low-level radiation, require nothing less than your prompt attention to this matter.

Sincerely,

John A. Durkin

JAD/fnw

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SUNDAY, FEBRUARY 19, 1978

The danger of radiation at the Portsmouth shipyard

N-sub workers run risk of cancer

The Portsmouth Naval Shipyard, which has brought pride and a measure of prosperity to northern New England since 1800, now may be harboring a nuclear-age health hazard

A study by The Globe Spotlight Team, conducted with medical experts, has found an alarming rate of cancer deaths among shipyard workers whose jobs brought them into the radiation field of nuclear submarine reactors

The Globe survey—the first of its kind done on the Navy's civilian nuclear workers--found that employees exposed to radiation have a cancer death rate of more than twice the national average and nearly 80 percent higher than the rate for other shipyard workers who did no nuclear work

About one out of every four of the yard's 20,000 civilian workers has been involved in the overhaul and repair of nuclear submarines since that kind of work first began at the yard in 1959.

While the shipyard is a showcase for the Navy's submarine fleet and a vital cog in the region's economy, it also is becoming a focal point in a rapidly expanding national debate over the danger to industrial workers from exposure to radiation.

At the yard, nuclear workers do tasks, from welding to painting, that expose them to limited, regular amounts of radiation and radioactive material in the air that is stirred up while they work around uranium-powered submarine reactors.

The radiation health issue is being aired currently in Congress before a House subcommittee examining the adequacy of existing safety procedures for protecting public and private employees who work with radioactive materials.

The Navy, which has turned down Globe requests for information about radiation effects on its employees, contends that its exposure limits are safe and that no employee has ever died or had health problems due to low-level doses of radiation.

Despite The Globe findings and some recent scientific studies, the Navy insists the danger to nuclear workers is so slight that it is less than the risk "regularly accepted in normal industrial work"

Although the Navy stressed it uses radiation standards deemed safe by the federal government, it affirmed it never studied the disputed issue of the long range effects of constant, low-level exposure on the health of its workers.

Last Friday the Navy suddenly announced it has asked the US Dept. of Energy to oversee a study of possible links between radiation and cancer among shipyard workers Shipyard officials were unable to provide a reason for the abrupt decision by the Navy to initiate such a review, and were unable to say what role, if any, The Globe's investigation played in the decision.

The two-month Globe study, conducted in cooperation with Dr. Thomas Najarian of Belmont and based on hundreds of interviews with the families of deceased men who worked at the yard, revealed

--The cancer death rate for shipyard workers found exposed to radiation is 38.4 percent while the rate among nonexposed employees is 21.7 percent. Nationally, the cancer death rate for the general population is about 18 percent.

--The leukemia death rate for shipyard employees who worked in exposed areas is 450 percent higher than the rate for the general population. While less than 1 percent of deaths nationally are caused by leukemia, 4 percent of the employees found exposed to radiation at the yard have died from the blood disease.

--Death by cancers of the lymph glands, another major cancer category, also were more prevalent among the radiation workers—125 percent higher than the national rate and 60 percent above the rate for nonexposed shipyard employees

--The high cancer death rate for shipyard radiation workers has remained relatively steady since nuclear submarine repair work began—despite assurances by government and naval officials that safety precautions have been regularly improved since 1959. The cancer death rate for radiation workers has ranged from 43 percent in the early years to 37 percent for 1976-77.

SPOTLIGHT, Page 8

Portsmouth workers run cancer risk

★SPOTLIGHT

Continued from Page 1

The most startling statistic emerged when the deceased nuclear and deceased nonnuclear shipyard workers were each segregated into age groups Between the ages of 60-69, nearly 60 percent of those workers whose jobs involved exposure to radiation died of cancer, for nonnuclear workers in the same age range, the cancer death rate was 26.1 percent

The reason, according to medical researchers, may be the long germination period anywhere from 8 to 10 years -between the exposure to radiation of middle aged workers in the early 1960s and the outbreak of latent cancer cells in the 1970s

The possibility that the results of The Globe's study are erroneous is slight, according to statistical experts who have reviewed them The scientists who have examined the data say the odds are only one in 100,000 that the finding are attributable to chance --a standard that is better than what is generally acceptable in scientific research

The study's data was analyzed by Dr Najarian, a hematology fellow with the Veterans Administration Hospital in Boston, who was first alerted to the potential problem of cancer among nuclear workers last October

At that time, Dr Najarian examined a retired welder who had worked with radiation at the shipyard and who mentioned that some of his co-workers had died at young ages The retiree was later diagnosed as having a form of leukemia

The underpinning of The Globe's research was the examination of 100,000 death certificates in Maine, New Hampshire and Massachusetts The names of 1722 deceased shipyard workers and the various causes of their deaths were taken from records dating back to 1959

Globe reporters were then able to interview the next of kin of 592 workers to determine if the men had been exposed to radiation at the yard, which is located in Kittery, Maine, near the New Hampshire and Massachusetts borders

The net result was that the cancer death rate for employees identified by kin as nuclear workers was found to be 35.4 percent, or 56 of 146 deaths. The figures for nonnuclear workers were 97 cancer deaths out of 446, or 21.7 percent

Dr Najarian, a graduate of MIT and Harvard Medical School, and Prof. Theodore Colton of Dartmouth Medical School, are preparing an in-depth, technical analysis on the Portsmouth shipyard work force for publication in a scientific journal.

Dr Najarian says the data indicates that the cancer incidents are "way out of proportion" with medically sound projection rates for any healthy working group

He said the research raises the possibility that the nuclear workers' "radiation badges," which measure exposure to invisible rays, are deficient in that they offer no protection against the radioactive "dust" that can enter the body by inhalation or cuts and bruises in the skin.

Dr Najarian said that the lodging of undetected "internal emitters" in the body, which continue to discharge radiation, could be one of the reasons for the increased incidence of cancer among the exposed shipyard workers- in the same way it appears to be a factor among victims of atomic fall-out who are showered miles away from the bomb's blast.

After being briefed on the study's findings and methodology, two federal researchers studying radiation effects on humans said the cancer death rate among shipyard workers should be "exhaustively researched" by scientists and government officials

"The work appears to be an excellent pilot study with clear, suggestive evidence that there is definitely a problem here," said one of the researchers, a medical doctor with the US Food and Drug Administration

In contrast, the Navy, after being informed of The Globe's findings as part of a written interview with shipyard commander W D McDonough, would not commit itself to studying the problem on its own using definitive employee records regarding radiation exposure

Capt McDonough, who refused to give a face-to-face interview, then distributed The Globe's data to 12 New England congressmen—an unauthorized release of tentative findings that has been protested by The Globe to Secretary of the Navy W Graham Claytor Jr and Secretary of Defense Harold S Brown

Previously, the Department of the Navy rejected The Globe's Freedom of Information request to provide the names of those shipyard workers who have been exposed to radiation since the nuclear submarine repair work started in 1959 The information has been compiled annually in so-called "personnel exposure" reports.

The information was withheld on the grounds that it would invade the privacy of the civilian workers according to Richard C Bassett, head of the office of Congressional and Public Affairs for the Navy Department

"We considered the misunderstanding among the public as to the effects of radiation," Bassett said, "and we didn't want to expose any of these workers to that misunderstanding

"Why, some people even feel that being exposed to a small amount of radiation would cause a person to glow in the dark," Bassett said "Now that may be an exaggeration but some people do feel there is a health risk in being exposed to radiation."

In late January, the Navy denied a further request from The Globe that the Navy identify which of the 1722 workers whose names were taken from death certificates by reporters were exposed to radiation—information readily available in Navy files This would have allowed The Globe a means to double check the memories of next of kin.

Both denials will be appealed by The Globe to the Navy's Judge Advocate office.

Radiation work began at the Navy's yard in 1959 with the initial overhauling of the nation's first nuclear submarine, the USS Nautilus Since then, an estimated 3000 to 5000 of its civilian workers have been exposed to radiation and Portsmouth shipyard has become one of nine facilities used by the Navy across the country to tend to its fleet of 150 nuclear submarines.

Radiation danger at Portsmouth

Cont'd from preceding page

According to Navy officials the workers — for the most part welders, machinists, electricians, pipe and shipfitters — are given no incentives, such as increased pay, to work on the nuclear submarines because the radiation amounts received are below safety limits set by the government.

Over the years the Navy, while insisting that the health risks are negligible, has moved to reduce the effects of radiation on nuclear workers.

In 1966, seven years after the nuclear repair work began, the Navy, following the recommendation of the International Commission on Radiological Protection, cut by more than half the annual radiation dose to which each worker could be exposed.

Also, during the past 15 years the number of radiation workers has been gradually reduced from about 2500 to 1400. The Navy says the decrease is attributable to a concerted effort to keep exposure levels down, along with better trained and supervised workers.

Although union officials interviewed said that safety precautions have been increased since the early days, they said there is growing apprehension among workers about the long range health effects of radiation exposure.

"These men don't know too much about the scientific ins and outs of the thing (radiation)," said Raymond Hall of the pipefitters union. "But whenever they hear somebody died of cancer, the first thing they want to know is: Did he work nuclear?" It spooks a lot of guys."

The Navy, as well as other federal agencies, bases its radiation safety policy on past studies which minimize the health risks from low level radiation exposure.

The studies contend that to double the chance of contracting leukemia, a nuclear worker would have to be exposed to at least 15 times more radiation over 20 years than a member of the general public would receive during the same period from environmental radiation sources, such as cosmic rays and certain minerals.

To double the incidence of other forms of cancer among nuclear workers, the studies state, the exposure level must shoot up dramatically to a rate of at least 90 times more than that experienced by the general public.

Just why radiation exposure can lead to cancer is not precisely known. Many scientists believe that radiation affects living cells, which constantly grow, reproduce and die. Cells that are affected by radiation often die or lose their reproductive capacity, they say.

In the last year, two studies have emerged which are challenging the long standing adherence to the maxim of minimal risk associated with small amounts of radiation exposure.

The first, commissioned by the federal government in 1964, researched the causes of death of 3520 workers exposed to radiation since World War II at an atomic plant in Hanford, Wash.

In a report released last October, the researchers found that to double his possibility of dying of cancer, a worker at the Hanford plant would have had to have been exposed to only 30 REMS of radiation — an amount that is ten times less than previously accepted reports by the government had indicated.

A REM is the standard used to measure the amount of radiation absorbed by the body. A standard chest X-ray exposes a person to half a REM.

Following accepted government standards, the Navy limits the amount of radiation to which its employees can be exposed to five REMS for each year he works at the shipyard. There are no other cumulative limits, but the Navy says no Portsmouth shipyard worker has ever been exposed to more than 40 REMS during his employment there. The amounts each nuclear worker is exposed to are measured by radiation-sensitive badges worn by the men.

But an investigation that is still being conducted by the US Center for Disease Control in Atlanta, Ga., could place the health danger at even lower amounts of radiation exposure — perhaps as low as one or two REMS.

The preliminary findings of the center's investigation show a 25 times greater leukemia rate among a group of soldiers who were ordered in 1957 to witness an atomic bomb explosion for a US Army experiment at Yucca Flat, Nev. In the experiment, which was code named "Smoky," the soldiers were exposed to an average of only 1.25 REMS of radiation, according to the US Defense Department.

The House subcommittee on health and environment has been holding hearings in Washington for the last two months in an attempt to resolve the dispute as to whether government accepted radiation limits heighten a worker's chance of contracting cancer or leukemia.

One theory, presently being examined by the "Smoky" researchers, is that the increased number of cancers is not attributable to the relatively low levels

N-sub workers run cancer risk

Cont'd from preceding page

of radiation measured by the nuclear worker's film badge.

Instead, the researchers believe, the danger may come from the undetected radioactive contaminants, such as dust and debris, found in atomic bomb fallout and generated by repair work on nuclear submarine reactors.

The prevailing view has held that since such contaminants do not permeate the skin, they are relatively harmless to the worker.

However, as Dr. Gerry Stein of the Center for Disease Control notes, these contaminants can enter a worker's body either by being inhaled or through an abrasion in his skin. "Having penetrated the skin, these rays stay inside the body and continue to emit radiation for years. That's what makes them so dangerous," Dr Stein said.

Because of new information, scientific and public attention to the possible hazards of low-level radiation is increasing, a prospect that heartens researchers at the Atlanta center.

"Right now, we don't know what the long-term effect of low-level radiation is," said Dr. Stein. Although it was once thought otherwise, he said, "it may be that no matter what amount of radiation you are exposed to, your health will be adversely affected."

This article was prepared by The Globe Spotlight Team which consists of Editor Gerard M O'Neill, Assistant Editor Stephen A Kurkjian, and reporters Richard S Kindleberger and William M Doherty, and research assistant Joan Vennochi. The Spotlight Team also was assisted by Herbert Black, a retired Globe medical editor.

be that the CDC is very qualified to assemble that. But the other aspect of that is the evaluation of the whole range of low-level radiation dangers.

I know that the Academy of Sciences has had a group that has certainly demonstrated some objectivity in this area, although they have not been picked up by the establishment as such. The group is studying the biological effects of ionization and radiation. I am concerned that this panel, when we get to it, have the kind of expertise that can make a very solid scientific judgment. I am not so sure that would happen if you simply pull scientists together who do not have a background in this area.

Senator DURKIN. Well, that is why, as I said in the letter to the President and the statement, I am sure there are many people in the country that can do that. I think the CDC is particularly well equipped to gather the data. You cannot have competing investigations, everybody putting footprints in the files, and pretty soon the files are useless. I think the CDC is particularly well equipped to conduct the investigation.

But it is a major problem, it has countrywide ramifications, and I think their investigatory work, their data-gathering work should be monitored, reviewed, and coordinated; and the decisions come not from a governmental agency or governmental bureaucracy, but the ultimate recommendations, the ultimate decisions, come from a panel. That is why I suggested Dr. Morgan. I do not know Dr. Morgan personally, but Dr. Morgan has a fine record; he comes from a fine State. And Dr. Mancuso has a fine record. Dr. Bross has a fine record, and they all have histories of work in this field. That is why I think it is incumbent on the President to address this and come up with a panel. I am not suggesting any particular number, but come up with a panel to meet your concerns, but yet has the independent experts. If the President does not, I think it is incumbent upon Congress to do so.

Senator HATHAWAY. Let me ask you, John, you would envision, though, that the blue-ribbon panel would go right back to the individual data if it wanted to, it would not be restricted to the conclusions of the CDC.

Senator DURKIN. Right.

Senator HATHAWAY. They could go right back, look at the records.

Senator DURKIN. They would monitor, review, coordinate, investigate to the extent necessary. No, I am not talking about the board of directors of the Book of the Month Club, some honorary token appointment. They would be actively and agressively involved.

Mr. WALGREN. I would only like to add, it is the responsibility of this committee to be satisfied, and perhaps even play a role in selecting that body because it has the public welfare as its greatest concern. Now, I do believe the President has the same responsibility.

Mr. ROGERS. Yes.

Senator DURKIN. Well, unfortunately the public does not have much confidence in us. I think that translates through the bureaucracy.

Mr. ROGERS. Off the record.

[Discussion off the record.]

Mr. ROGERS. Thank you, we appreciate your helpful contribution.

Senator DURKIN. Thank you, Mr. Chairman.

Mr. ROGERS. We will be glad to keep in touch with you, if you have any further suggestions.

Senator DURKIN. Thank you, Mr. Chairman.

Mr. ROGERS. We now have one of the Members of the House, one of our distinguished colleagues from New Hampshire, Hon. Norman E. D'Amours.

We welcome you to the committee, your statement will be made a part of the record in full, and you may proceed as you desire.

STATEMENT OF HON. NORMAN E. D'AMOURS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW HAMPSHIRE

Mr. D'AMOURS. Thank you, Mr. Chairman, Senator Hathaway, members of the subcommittee.

I represent an area which supplies many of the workers at the shipyard in question. I thank you for the concern you have demonstrated by conducting this hearing, along with the interest you have been showing in the whole problem of low-level radiation exposure and its effect upon employees of the Federal Government and members of our armed services over the years.

First of all, I thank Senators Durkin and McIntyre. I am generally in agreement with them, at least to the extent that we all feel the need for a thorough and independent investigation of the Portsmouth situation. In my opinion the Navy ought not to be in a position of investigating its own procedures, nor in the position of choosing the investigating staff or personnel. That is why I was delighted at the direction that Secretary Califano of HEW took in naming the Center for Disease Control to conduct such an investigation. I certainly hope that this subcommittee, after all the testimony today, will agree that the Center for Disease Control is the agency to do that job. Certainly, having made that determination your support to the Center and its investigators would be very helpful in seeing that they have access to the records and testimony, and data that they are going to be needing.

I was disturbed just last week to learn from Dr. Vernon Rose of the National Institute for Occupational Safety and Health that he was meeting resistance from the Navy in his attempt to carry out the investigation for the Center for Disease Control. Dr. Rose, in his initial contacts with the Navy, was simply referred to the Department of Energy. I understand the Navy has, at least to some extent, since agreed to be somewhat more cooperative.

Placing the matter in the hands of Center for Disease Control, given their experience in studying health threats to the public, I think, places this issue in the scientific community where it properly belongs. The Center is equipped to conduct a scientific study in which all parties, I believe, can have complete confidence.

Mr. Chairman, there is only one paramount concern here, and that is the health and safety of the tens of thousands of present, former, and future shipyard workers. All other considerations are secondary compared to that major one.

The squabbling between the Center for Disease Control and the Department of Energy and the Navy has already, I think, eroded some public confidence in the ability of any Government agency to dispassionately and competently investigate the risk involved in low-level radiation exposure. This bureaucratic infighting does not serve the best interest of the shipyard workers, or the Nation's defense. Already in the Navy's actions I can see a type of response which will only serve to inflame the situation and make a careful study to make factual determinations all that much more difficult.

In reviewing material on this matter I note that one of the Navy's responses so far has been repeatedly to cite that it is in full compliance with standards developed by the U.S. Environmental Protection Agency, the U.S. National Council on Radiation Protection and Measurements, the Nuclear Regulatory Commission, the Department of Labor, and the International Commission on Radiological Protection. I think the Navy is missing the point of these proceedings.

The question is not and ought not to be whether or not standards are being complied with. The question ought to be whether the standards are sufficient today, and whether they have been sufficient in the past.

So, I am not going to take any more of the committee's time. I just hope that with the support and backing of this subcommittee, that the CDC, the Center for Disease Control, can get quickly and expeditiously to the task of conducting a systematic and scientific investigation of the whole matter.

I thank you for your time.

Mr. ROGERS. Thank you so much for being here, and for your suggestions to the committee. Senator Hathaway?

Senator HATHAWAY. Thank you very much.

Do you agree with respect to Senator Durkin's suggestion of the blue-ribbon panel?

Mr. D'AMOURS. Well, I do not know whether I agree or not. I have not given much thought to a blue-ribbon panel. What I am worried about is that we are going to become part of the problem, rather than part of the solution, by squabbling among ourselves. I think the question is to get the CDC going. They are ready to go. They are waiting to go, and let's get them started. If we start worrying about selecting a new panel, I think we are perhaps becoming part of the problem, rather than part of the solution.

I would like to further suggest that as of this time I have full confidence in the Center for Disease Control, and nobody has given me any reason to suggest that I should not. So, I do not want to make an ad priori determination as to whether or not their study is going to be credible or worthwhile. I think we owe it to them, at least, to see what they are going to come up with before we make a determination as to whether it is credible. That is one of the considerations. The overriding consideration, though, is that we have got to get moving on this study because there is so much more at stake, as we know, than just public health. There is also the matter of recruiting the people who work on these ships.

I am for getting moving, and getting moving quickly.

Mr. ROGERS. Thank you. Dr. Carter?

Mr. CARTER. Thank you, Mr. Chairman.

Let me congratulate you on your position, I certainly agree with you that this study should be conducted by the Center for Disease Control in Atlanta, which has shown its fairness and effectiveness in other studies, including the one at least partially completed on the atomic blast, "Smoky."

I agree with you. Personally I do not think that another panel is necessary.

Thank you, Mr. Chairman.

Mr. ROGERS. Mr. Markey?

Mr. MARKEY. No questions.

Mr. ROGERS. Mr. Walgren?

Mr. WALGREN. No questions, Mr. Chairman.

Mr. ROGERS. Thank you for your presence, you have been most helpful.

Mr. D'AMOURS. Thank you, gentlemen.

Mr. ROGERS. Now I am very pleased to have Senator Hathaway give his comments, and to introduce the next witness. We are grateful to you for being here, and I think this is excellent for the Senate and the House to come together, the two committees that are concerned, so that we can have some joint thinking and joint action.

STATEMENT OF HON. WILLIAM D. HATHAWAY, A U.S. SENATOR FROM THE STATE OF MAINE

Senator HATHAWAY. Mr. Chairman, thank you very much. I am very pleased to participate in this joint inquiry of the Senate and House Subcommittees on Health into the potential dangers from radiation exposure to workers on America's nuclear submarines.

I certainly appreciate your cooperation, Paul, in this regard, your dedication, your hard work and innumerable accomplishments on behalf of all Americans, which are very well known. It has been my privilege as a member of the Health Subcommittee of the Senate to work with you in conference committees and on such far-reaching initiatives as health planning, health maintenance organizations, and health manpower legislation.

Of course, as chairman of the Senate Subcommittee on Alcoholism and Drugs, I particularly appreciated the partnership which you and I have established.

The hearing this morning continues that tradition. Based on preliminary reports of the health hazards from radiation exposure to workers in the Kittery-Portsmouth Naval Shipyard, I had tentatively arranged for hearings of the Senate Health Subcommittee earlier this year, but in order to allow for the completion of the detailed study and to insure that such a hearing would have the full benefit of all available data and relevant findings, the Senate hearings were postponed until March 6.

Independently, the House Subcommittee on Health has engaged in an excellent and a wide-ranging inquiry into the broader health problems involved in radiation and had planned this hearing to focus on the issues of particular concern to me. Consequently, Chairman Rogers graciously suggested the format of a joint inquiry to facilitate the consideration of Congress as a whole of this important issue.

The study is now finished, and this morning we will hear its conclusions. Dr. Najarian has apparently uncovered a serious health problem. According to his findings, the cancer death rate among workers on America's early nuclear submarines at Kittery-

Portsmouth Naval Yard is more that twice that for the general population.

It is my understanding that the Navy disputes the doctor's findings and consequently, I am prepared to listen with interest to the testimony of both Dr. Najarian and the Navy witnesses.

If in fact a health problem does exist, we have a responsibility to identify the individuals at risk both retired and currently employed, and notify them of the possible danger and any measures which can be taken to minimize the possibility of ill health due to radiation exposure. And if our current controls at the Kittery yard and others are not adequate, we must move immediately to eliminate the hazards. This is a serious matter which requires the immediate and complete cooperation of all parties involved. We cannot afford to tolerate anything less.

Mr. Chairman, it is now my pleasure to introduce Dr. Thomas Najarian. Dr. Najarian is a hematologist at the Veterans Administration Hospital in Boston. A graduate of MIT and Harvard Medical School, he conducted this study in his individual capacity. Dr. Najarian's interest arose when one of his patients was being treated for leukemia. The patient informed Dr. Najarian that he, the patient, had worked on the construction of early nuclear submarines, and that a number of his coworkers had died at an early age.

Dr. Najarian, we thank you for being here and welcome your testimony.

Mr. ROGERS. Dr. Najarian, I would like to join Senator Hathaway in welcoming you to the committee. We appreciate your cooperation, and the fact that you are willing to share with the committee the results of your study, even though it has not yet been published in the medical literature.

Thank you for being here, and you may proceed as you desire.

STATEMENT OF THOMAS NAJARIAN, M.D., FELLOW IN HEMATOLOGY, VETERANS ADMINISTRATION HOSPITAL, BOSTON

Dr. NAJARIAN. Thank you very much, Chairman Rogers, and other members of the Rogers committee for inviting me here today. I do feel a little bit handicapped because the paper has not actually been published in a medical journal at this time.

I would like to say a few remarks before I read my prepared text that I have here, and that is that this study because it was reported first in the Boston Globe, some things have been translated to the lay press, which are not technically correct. The study was a study of proportional mortality, it had nothing to do with cancer rates, or leukemia death rates. Because the Navy itself does not have a copy of this study, they are even at a handicap in criticizing it. I believe that someone from the CDC has reviewed it. It was wired to them yesterday and they may be able to make comments about it, if they wish.

I did not have the problem of having my funding cut off except that at a certain point my wife informed me that our funds were getting low, I really needed help in completing the study, which is the reason I went to the Boston Globe Spotlight Team.

I would like to thank the Boston Globe Spotlight Team for their assistance and moral support in this project. Without their help the study may have taken me an additional year to complete, or may not have been completed at all.

I was also asked by the Veterans' Administration to state clearly that I am speaking entirely as a private citizen, the research and my statements are not supported in any way by the VA, and have no connection whatsoever with any VA or other Government agency.

My ultimate motivations for doing this study were three.

Mr. ROGERS. Excuse me, may I interrupt? You may want to pull the microphone just a bit closer. Thank you.

Dr. NAJARIAN. I had three motivations, major motivations for doing this study. No. 1, if a health hazard existed for nuclear workers I thought this hazard should be identified so that measures can be taken to better insure the health of the workers.

Two, there were surprisingly few studies on the effects of chronic low-level exposure to radiation and radioactive materials. These studies need to be done if we are to be able to make rational choices about the risks and benefits of various means of producing energy.

I have included—I do not know if it has been xeroxed—but I have here some xeroxed pages from the BEIR report, and this was the study commissioned by the Government and, published in 1972, which was a summary of all radiation effects up to that time. On risk estimation to chronic low-level exposure it starts off with this sentence:

> To estimate the actual risk of cancer attributable to a particular increase in the level of exposure in the general population to ionizing radiation would require systematic information on the effect of lifelong low-dose radiation that is simply not available.

I think that summarizes that up until that time, at least, there were really no studies of this sort available.

The third reason was that after receiving some of the early responses from the Navy when I voiced my concerns both to the Navy and the President and Senator Kennedy about the possible health hazards of nuclear workers, I realized that I would have to undertake a sizable study myself in order to stimulate the appropriate research.

I should mention that I first heard from Government officials—the actual dates—I believe Senator McIntyre's office was the first to call me on December 9, 1977, and shortly after that a representative from Senator Hathaway's office also contacted me. Since then I have been contacted by other people.

I would like to say that I am not necessarily an opponent of nuclear energy. In fact, I have been in favor of a balanced approach to the Nation's energy problems, and I have enclosed in here a copy of a letter that I wrote to the editor of the Boston Globe in 1974, which supported nuclear power. I am talking about a risk not to the general population, but to a very small group within the shipyard who do nuclear work. The workers who are not nuclear workers in the shipyard who are also exposed to other things, such as asbestos and organic solvents, did not have a statistically significant increase in proportion mortality from cancer or leukemia. So, just the fact that they are next to it does not convey upon them some danger, apparently.

One final note before I give you a background on this project. Comdr. Hyman Rickover and his staff should feel just pride in their accomplishments in initiating the Nation's nuclear propulsion program. The nuclear submarines are a vital part of this Nation's defense and security.

If workers who repair and refuel these submarines have an increased risk for certain diseases at early ages, as I am quite certain they do, then these people shoud be treated the same as anyone who has served this country for the protection and defense of its people. The workers deserve all the safety precautions possible while they are working. One can never know if the safety precautions used today are adequate if one refuses to study the possible long-term effects of radiation on the workers after they are retired from the Navy propulsion program. One should not deal with potential health problems by simply ignoring or denying them.

At this time I would like to give a little back ground information on the project.

In late September, 1977, Mr. Adolph Pohopek, a former nuclear welder at the Portsmouth Naval Shipyard was admitted to the Boston VA Hospital for diagnosis and treatment of an aplastic anemia-like picture. As a hematology fellow at the VA I was asked to evaluate the patient.

During one examination Mr. Pohopek asked if his radiation work at the shipyard might have had something to do with his illness, especially since many other coworkers—mostly younger than he—had passed away recently. The radiation exposure to Mr. Pohopek had been reported by the Portsmouth Naval Shipyard to his previous doctor at the Exeter, N.H., clinic as a total of 1 to 2 rem for 6 years of nuclear work. This would have increased Mr. Pohopek's chances of developing leukemia—which he was later diagnosed as having—by only 1 to 2 percent, based on previous studies of radiation effects on man. Because his reported radiation exposure was so low I told the patient initially that I did not think his work would likely have caused his leukemia.

However because he reported that so many of his coworkers had died young, I felt that the matter deserved a brief look. I spoke with officials at my hospital about this, and they said that they would inform the CDC and the Brighton Marine to look into this matter. I felt a personal responsibility to study this myself, since I had no way of knowing if any Government agency would initiate such a study merely because of a single reported case of leukemia.

The VA Hospital director said that as a private citizen I would look into this on my own time, as long as I did not earn money from the work, such as from a research grant from outside the VA hospital.

On October 4 I called the PNS and spoke with Dr. Robert Judson. He was unaware of any health problem but did state there was no followup on past employees. I decided to spend one vacation day—on October 5—visiting the Portsmouth Naval Shipyard to talk with this doctor, radiation control workers, and shipyard workers whose names were given to me by Mr. Pohopek.

The workers at the shipyard gave me the names of about 50 past nuclear workers who worked in the early 1960's. Of the people they remembered about 10 had died, mostly in their 50's and some in their 40's. This seemed to me to be an unusually high number of men dying at early ages.

On October 7 I spoke with Dr. Boling at the Boston VA Hospital about possibly getting a grant from the VA to study this potential health problem. He stated that the levels of radiation were too low to have any significant health effects, and he did not believe that the VA would fund such research.

On October 8 I wrote to the PNS—Mr. Brennan at the Legal Office—requesting information about past employees, which would help in a preliminary study. I received an initial reply dated October 14. Because of the Privacy Act they would be unable to give me the addresses of former employees. The final reply on November 11 states that they have studied present workers and found no health effects associated with radiation exposures. This was not, however, a followup study.

On October 29 I mailed a letter and questionnaire to about 40 past and present nuclear workers, after I looked their names up in the phone book, asking for information on past workers. On November 4 the Boston VA Hospital—this was only 5 days later, or so—was contacted by the head of the Veterans' Administration National Research Allocation asking who I was, and who was funding my research. Apparently some of my letters which were mailed to present PNS workers were brought to the attention of a PNS official who notified the Navy Department in Washington, who in turn notified the Veterans Research Bureau. I am speculating on this chain of events, but something like this must have happened in order for our VA hospital to have been called by the Veterans' Administration Office in Washington. The officials at the Boston VA Hospital made it clear to me that all further work must specify that my research is not supported in any way by the Government or the VA hospital. I have not included this in the written statement, but they also requested from me at that time verbally a copy of every single piece of correspondence I had, either with the Navy or any politician, or any personnel. I asked them to write it out in writing why they wanted that information and what they intended to do with it, and I never heard from them after that.

Over the next 2 weeks after the October 29 mailing to 40 former and present employees at the PNS I began to receive replies. The initial reports indicated to me that there indeed may have been a health hazard. Because of this I wrote a letter to Senator Kennedy and President Carter on November 7, describing the possible health hazard and asking for a Government followup study of past nuclear workers.

Over the next several days I received some alarming replies—this was after I wrote this letter—of unusually high numbers of leukemia deaths of past nuclear workers. I realized that this information was selected and not random data, and would be useless as a scientific study. However, if the final results of a study were only a fraction of the initial results in importance, a major health effect was taking place.

The kind of study needed was beyond the scope of one person to do, working on his own time after work. The VA would not fund the research and I could not get any outside grant, so, since I had to do it myself, I decided that I would go to the Boston Globe for help. I was disheartened at that time about the fact that I seemed to be the only person concerned about a health hazard there.

In mid-November, 1977, I discussed this project with a member of the Boston Globe Spotlight Team to see if they would assist. The Globe team eventually began work on the project, and it was through their help that this final study was completed. A study of this size that I have completed with the Globe team's help was necessary because the results would be pitted against some large Government followup studies on A-bomb survivors which show different effects from certain levels of radiation exposure than the results of my study. In addition, the Navy's claim that they have studied 56,000 employees exposed to radiation and found that the radiation workers have a lower incidence of leukemia and cancer compared to the general population would have to be countered by a little more than a few isolated case reports.

In mid-December, with the help of some medical students and relatives, I began to look through death certificates from the State of New Hampshire for former workers of the PNS. By mid-January 1978, we had collected over 900 names of former PNS workers after searching through over 90,000 death certificates. The Boston Globe team collected an additional 800 names of former workers at the PNS from Maine, New Hampshire, and Massachusetts. The main problem at that time was not knowing which were nuclear and which were nonnuclear workers. The Globe team, under by strict direction, obtained this information from next of kin for nearly 600 former workers by telephone interviews.

Dr. Ted Colton assisted in the final experimental design, data analysis, statistical analysis, and writing of the paper.

I realize the limitations of this study as well as anyone because I designed the study, analyzed much of the data, and exercised control over all aspects of the research. But I would like to emphasize, that the major limitations were caused by the Navy itself by their continued refusal of Freedom of Information Act requests for the names only of former nuclear shipyard workers, information which I know that I was entitled to from a Government lawyer who had handled such requests. The Boston Globe asked the Navy that if we submitted to them a list of deceased workers from the Portsmouth Naval Shipyard, would they identify who were the nuclear and who the nonnuclear workers. The Navy refused again, stating that they would not want to invade the privacy of the deceased former workers.

One final statement, it is a little bit technical, but there are some scientists here and this is mainly directed at them, and also the Navy itself.

I have estimated—and these estimates could be off by small amounts—this analysis has nothing to do with the study itself—that the nuclear workers at the Portsmouth Naval Shipyard from 1959 to 1977 represent a total of about 75,000 man-years at a maximum. Since the incidence of leukemia deaths in the general population is roughly 7 per 100,000 per year, there would be an expected five total leukemia deaths among nuclear workers from 1959 to 1977. This total can also be arrived at by another method, another estimating method. For U.S. white males of a similar age group the percentage of leukemia deaths represents about 0.7 percent of the total deaths. I estimate that we have found roughly 60 percent of the total PNS deaths with our search. We did not look at any death certificates before 1965 from Massachusetts, and there were some years from New Hampshire that we simply did not finish scanning because we ran out of time for a particular year during a visit to the Concord Capital. In addition, people who moved far away after retiring, or do not list the PNS as their last occupation, would be missed. This would mean that the total deaths from 1959 of former workers of the PNS would be around 3,000. If the nuclear versus nonnuclear deaths remain roughly the same for the 3,000 as they did for our 1,700 deaths, one would expect about 750 deaths of former nuclear workers since 1959. Multiply this by 0.7 percent, and one again would predict about five total leukemia deaths of past nuclear workers.

Now, that would be the expected if they were the same as the U.S. national average, five leukemia deaths.

Our study located six leukemia deaths of former nuclear workers; and again, that was only a limited sample. In addition I have managed to obtain information on four other leukemia deaths which were in the original 1,700 death certificates that we located, but that the Globe had been unable to get information on by calling the next of kin. Of those four, three were former nuclear workers and one was a nonnuclear worker. I also know of another leukemia death which we did not have in our death certificate list at all, and one case of a person, Mr. Phohopek, who is alive with leukemia.

Among the group of deaths we did obtain information on, the ratio of nuclear to nonnuclear leukemia deaths was three to one. Assuming that the breakdown of nuclear to nonnuclear leukemia deaths is only 50-50 which would have to place a higher percentage of leukemia deaths in the nonnuclear group as well. The nonnuclear group would have to have a higher incidence than the U.S. average to have a 50-50 breakdown. Then in the group we did not identify, this would predict an additional four nuclear worker leukemia deaths, all under age 80, from our unknown group; and an additional eight nuclear worker leukemia deaths among certificates we did not obtain for one reason or another.

In other words, I have already collected 10 definite leukemia deaths, and 1 person alive with leukemia, and predict that at a minimum there would be an additional 12 leukemia deaths that we have not identified. This gives a total of 22 estimated total leukemia deaths among former nuclear workers at the PNS where the expected number would be 5. This is more than four times the expected amount and indicates a radiation effect that would be equivalent to an average exposure of roughly 100 to 200 rems per worker, based on previous studies; instead of the average noted by the Navy of between 2 to 10 rems total lifetime exposure over and above natural background sources.

Further, if any study is done on this population that does not show an increase in leukemia deaths, and an increase in cancer deaths I would like to see all the names of former nuclear workers who died of leukemia in the study to see if the records have been altered to hide the fact that certain workers were nuclear. If any of the names that I have collected are not on the list, I would suspect that the original information as to who worked at the shipyard or who was nuclear has been altered.

I would like to just discuss briefly the findings of the study. It showed that the proportional mortality for the nuclear versus the nonnuclear PNS workers were increased by about 60 percent, and compared to the U.S. population by more than 75 percent. The leukemia deaths among nuclear workers were increased either compared to the U.S. population or to the nonnuclear workers by more than 450 percent in the study.

Mr. ROGERS. Give us that fact again, now.

Dr. NAJARIAN. The proportional mortality for leukemia among nuclear workers was increased by 450 percent over either the nonnuclear workers or the U.S. population for the same age group.

Again, this study has no way of predicting whether or not this risk is in fact greater than, let us say, other risks that are ordinarily accepted by people, including smoking cigarettes, which is very bad risk that most people do not seem to appreciate may shorten a person's life expectancy on the average of 8 to 10 years, if you smoke one or two packs of cigarettes a day. A study of this kind would be unable to predict how the risk of radiation work to these workers stands up against the smoking, which is probably about the worst risk that the general U.S. public will accept in something that they ordinarily do.

We also analyzed the smoking data, which we have not in fact completed and put into the paper at this time. It will probably be added at some later time. But there was in fact no difference, no statistically significant difference, in the percentage of smokers either in the nuclear or the nonnuclear group.

I also have a series of 16 question that were submitted by the Boston Globe to the Navy, that they answered. And also a statement by the Navy that was printed in the Boston Globe on February 24, and I presume other newspapers as well. This is a statement of response to the article that the Globe printed on this story.

I have a few other things that I would like to mention, that pertain to the death certificates. One of the questions that we ask—which is the last question that the Globe would ask anybody under my direction—was what the cause of death was according to the next of kin. This information was not used in the analysis. The death certificate was used in deciding whether it was a cancer or noncancer death.

There were four people who replied, who stated that their next of kin—and this is all nuclear workers now, former nuclear workers—that they had died of some form of cancer, or had cancer at the time of death. That was not included on the death certificates at all. This is out of a total of 146 nuclear workers that we were able to get information on. There were no disagreements among the more than 400 nonnuclear workers that we got information on, between what the next of kin stated and what the death certificates stated. I have listed these four people, and I have information as to where the death certificates are to be found. I have not tried to verify this information through medical records. I have not had the time to verify whether or not the patients' family histories are correct, or the death certificates are correct. In any case, as I said, these were all counted as noncancer deaths in the study.

Donald Gilday, whose death certificate said that he died of a cerebral hemorrhage and arteriosclerosis. His family said that the patient died of cancer of the lymph glands; that would be classified as another neoplasm of lymphatic tissue in the study.

James A. Coellner, whose death certificate said only that he had a heart attack and nothing else. The family said that the patient was in ill health for months before his death with a low blood count. This was not mentioned in the death certificate.

Leslie Marcotte, the death certificate states that the patient had liver failure, cirrhosis and biliary obstruction. The family said he died of cancer which has contracted 1 year before death. That could easily be a misunderstanding on the family's part, I have not tried to substantiate any of the families' claims here.

Murray Fred Crocket, the death certificate said that he died of a heart attack and general atherosclerosis. The patient's son said that his father died of cancer of the colon and circulation problems. I will give you better copies of this.

Mr. Rogers. That will be fine, and it will be made part of the record without objection.

Dr. Najarian. Now, in a letter from W. P. Arentzen, who is the vice admiral, Medical Corps, U.S. Navy, dated December 16, Mr. Arentzen stated that in 1966 the laboratory developed a longitudinal health survey which is an ongoing multiphase screening survey. One of my questions I would like to submit concerns this. This is apparently a study of naval personnel who have manned nuclear submarines. The letter omits any statement as to the results or methods of the study thus far. Enclosed is a copy of that letter, that is in the correspondence.

Also enclosed is a copy of a letter from the widow of a former Navy submarine chief, and again because of the early publicity in December about this, I received a number of letters from people across the country, telling me stories. Again, these are unsubstantiated.

She states that her husband contracted leukemia and died after serving on a nuclear submarine, and she alleges that her husband's doctors at the Bethesda National Institute—and I am quoting from the letter now—"National Institute of Health said his leukemia was caused by the atmosphere of the nuclear submarine." She also states that she met another submarine sailor and his wife in Bethesda, and this sailor also had leukemia.

I received a telephone call from a former sailor on a nuclear submarine who alleged to me the following, the sailor was Mr. Ernest Lacey, and I have his address here, 196 Flanders Road, Mystic, Conn. He stated that three of his former friends who served on the Robert E. Lee had died of lymphomas. These three sailors were Lt. Commander Walsh, Chief Petty Officer Lewis, and 2d Class Lt. Jesse McMinn. Mr. Lacey said that he had called me after reading that I was studying effects of radiation on nuclear submarine workers. He claims that he had notified the Navy about these deaths, but that no one seemed to be concerned. I have not tried to verify any of the above myself, and thus cannot testify as to the accuracy of Mr. Lacey's statements to me.

Then there are two separate people who I do not know if they know each other or not, but they reported to me separately incidents involving Electric Boat in Groton, Conn., and a Dr. McDugal. Again, because of the initial publicity that I was studying this, I received this information. The first is a letter from a woman, and it is a rather lengthy letter, but basically she says that her husband had aplastic anemia after working nuclear work. He had 'aplastic anemia about 10 years and eventually died from it. She had contacted a lawyer to try to get some compensation, apparently, from the Electric Boat. The lawyer eventually dropped the case, but one of the contentions she said is that her husband who, from what she described almost certainly did nuclear work, was in fact involved in carrying some material that was very highly radioactive and had to be put in a leaded box in a truck in order to be transported. He did this without any shielding or protection. In fact, Dr. McDugal wrote a letter stating that this patient was not a nuclear worker and that he had never come in contact with radiation.

In addition to that I received a phone call from a woman, Mrs. Ida Robson—and I have her address here—here husband died on April 9, 1966. He had done nuclear work as an inspector in nuclear quality control at Electric Boat. Her husband, Mr. James Myland Robson began to have problems 1 month before death. He consulted the shipyard doctor—again Dr. McDugal—who diagnosed it as a sore throat. Several weeks before death the patient noted bleeding gums, purple spots on the skin, the feeling of illness, and continued sore throat. For those who are not hematologists or medical doctors, those are suspicious signs for leukemia, although the symptoms could signify other conditions such as, aplastic anemia for one. He died within 1 month of these symptoms. His wife alleges that his death certificate states that here husband died of bilateral lobar pneumonia. Again, I do not have a copy of that death certificate, I am not certain who is supposed to have filled out the death certificate. The woman requested an autopsy from a medical examiner, Dr. Normand Rasmussen from Uncasville. About 2 months later the autopsy report was sent to the wife. She says that the autopsy report stated that her husband died of acute fulminating leukemia. The woman alleged that the death certificate was not changed to include these findings, despite her complaints to the shipyard and the shipyard doctor. I am not even sure if it was their responsibility to do such.

That is basically all I have to say. Thank you very much.

[The letters referred to by Dr. Najarian may be found in the subcommittee files.]

[Testimony resumes on p. 1252.]

[Navy responses to Boston Globe questions follow:]

NAVY RESPONSES TO BOSTON GLOBE QUESTIONS

1. Q: How long has radiation work been going on at the Shipyard? Provide a brief description of the necessity of the work?

A: Radiation work has been going on at Portsmouth since the first overhaul of a nuclear submarine in 1959. The necessity of this work is based upon the need to overhaul and refuel nuclear submarines for our Navy.

2. Q: Approximately how many men are presently working with radiation? What trades are involved? Is there any difference in their pay from the pay of non-nuclear workers? Has there been a decrease in the amount of men working radiation since the earlier years (1959-1963)? Has the percentage of employees working radiation decreased?

A: During calendar year 1977, approximately 1400 employees were monitored for radiation exposure. The trades involved are the typical shipbuilding/repair trades such as welders, shipfitters, pipefitters, machinists, electricians, inspectors, engineers, etc. In any one trade, there is no difference in pay because of nuclear work. There has been a general decrease in nuclear workers since the earlier years (1959-1963) (Avg. 1959-1963 was 2500, versus 1400 in 1977). The percentage of nuclear workers versus total shipyard employees has decreased since the earlier years (1959-1963) (Avg. 1959-1963 was 30% versus 20% in 1977)

3. Q: Trace the maximum amounts of radiation which has been allowable for the men to receive.

A: Since the beginning of radiation work in 1959 the Shipyard has had in effect radiation exposure limits which are consistent with those established by the U.S. Atomic Energy Commission (now the Nuclear Regulatory Commission). Specificially, the Shipyard's exposure limit since 1959 to the present has been 3 REM per calendar quarter. From 1966 to the present, a total annual exposure limit of 5 REM has been in effect in addition to the 3 REM per calendar quarter.

4. Q: How are the radiation amounts measured? Provide a brief description of how the badges work. Do the badges measure all types of radiation; that is, ALPHA and BETA rays as well as GAMMA rays? If not, how are ALPHA and BETA rays measured?

A: Radiation exposure is measured by a photodosimetric device called a film badge and also by thermoluminiscent dosimeters (TLDs). Film badges were used until Oct of 1974. Since Oct 1974, the Shipyard has been using TLDs to measure radiation exposure. A film badge contains one or more photographic emulsions (film packets) of various degrees of sensitivity to beta particles, gamma rays, X-rays, or to fast and thermal neutrons. Film packets are placed in holders which are specially designed to differentiate between these types of radiation. After exposure to radiation the film packets are developed under controlled procedures and the density, which is proportional to the amount of radiation received, is measured. Film badges detect beta, gamma, and X-ray energies. The thermoluminescent dosimeter consists of two chips of calcium fluoride, with added manganese, sealed in a glass envelope. The glass envelope is contained in a shielded case specially designed for energy response. These chips are in contact with a metalic heater strip. It is a characteristic of these chips to emit light when heated, provided they have been exposed to gamma radiation. The intensity of the light is directly proportional to the amount of radiation exposure. An electronic device measures the intensity of the light and converts this to a digital readout in units of radiation dose. The TLD measures gamma and X-ray radiation. A different type of TLD measures neutron radiation. Due to the limited range of beta radiation, the controls over, and the type of work performed during overhaul of nuclear submarines, personnel are not exposed to beta radiation. However, exposure of personnel to beta radiation is monitored by performing radiation surveys of work areas and controlled by the use of anticontamination clothing. Alpha radiation is not found in the nuclear power overhaul work performed at Portsmouth.

5. Q: Who keeps track of the amounts of radiation each man receives to make sure that an over-exposed man does not continue to work with radiation?

A: The Shipyard has in effect controls designed to prevent personnel from exceeding radiation exposure limits. The individual worker and the Shipyard Radiological Control Office monitor personnel radiation exposure. The Shipyard has a specially designed data processing program which keeps track of the radiation exposure each individual receives. Daily reports are issued which indicate each employee's current radiation exposure. This personnel radiation exposure program has a built-in "Alert" mechanism which helps prevent personnel from exceeding limits.

6. Q: What other facilities in the U.S. are doing this type of nuclear work? Does Portsmouth do more or less radiation work than other facilities? Is Portsmouth the biggest overhauler of nuclear submarines?

A: Other shipyards involved in the overhaul of nuclear submarines are Naval Shipyards: Norfolk, Charleston, Puget Sound, Mare Island and Pearl Harbor; and private shipyards: Electric Boat Division of General Dynamics at Groton, Conn; Newport News Shipbuilding and Drydock Co. at Newport News, Va; and Ingalls Shipbuilding Co. at Pascagoula, Miss. Portsmouth's amount of radiation work compared to other facilities varies as the number of submarines assigned to the various facilities at any time varies. Portsmouth is not the largest overhauler of nuclear submarines.

7. Q: How frequently must the subs be overhauled? Does the Shipyard work on the same sub over the years? Who determines that a certain sub will be overhauled at Portsmouth and not somewhere else?

A: The frequency of submarine overhauls varies, with the type and class of the various submarines, between approximately 4 and 9 years. The overhaul schedules sometimes assigns the same submarine to Portsmouth for subsequent overhauls. The Chief of Naval Operations assigns specific submarines to specific yards.

8. Q: Does Portsmouth build nuclear subs as well as overhaul them? Identify the submarines which have been built and/or overhauled at Portsmouth.

A: Since 1971 Portsmouth has been involved only in overhaul and repair of nuclear subs; prior to 1971 Portsmouth both built and overhauled subs. Ten nuclear submarines have been built at Portsmouth. They are: USS SWORDFISH (SSN579), USS SEADRAGON (SSN584), USS THRESHER (SSN593), USS ABRAHAM LINCOLN (SSBN602), USS JACK (SSN605), USS TINOSA (SSN606), USS JOHN ADAMS (SSBN620), USS NATHANAEL GREENE (SSBN636), USS GRAYLING (SSN646), USS SAND LANCE (SSN660). The following submarines have been at Portsmouth for overhaul work.

USS NAUTILUS (SSN571)
USS SEAWOLF (SSN575)
USS SWORDFISH (SSN579)
USS SEADRAGON (SSN584)
USS SKIPJACK (SSN585)
USS THRESHER (SSN593)
USS TULLIBEE (SSN597)
USS ABRAHAM LINCOLN (SSBN602)
USS JACK (SSN605)
USS TINOSA (SSN606)
USS DACE (SSN607)
USS SAM HOUSTON (SSBN609)
USS GREENLING (SSN614)
USS ANDREW JACKSON (SSBN619)
USS JOHN ADAMS (SSBN620)
USS HENRY CLAY (SSBN625)
USS TECUMSEH (SSBN628)
USS DANIEL BOONE (SSBN629)
USS JOHN C. CALHOUN (SSBN630)
USS SAM RAYBURN (SSBN635)
USS NATHANAEL GREENE (SSBN636)
USS WHALE (SSN638)
USS GEORGE BANCROFT (SSBN643)
USS GRAYLING (SSN646)

USS GEORGE C. MARSHALL (SSBN654)
USS GEORGE WASHINGTON CARVER (SSBN656)
USS FRANCIS SCOTT KEY (SSBN657)
USS MARIANO G. VALLEJO (SSBN658)
USS WILL ROGERS (SSBN659)
USS SAND LANCE (SSN660)
USS LAPON (SSN661)
USS HAMERHEAD (SSN663)
USS SEA DEVIL (SSN664)
USS FINBACK (SSN670)
USS FLYING FISH (SSN673)
USS TREPANG (SSN674)
USS BILLFISH (SSN676)
USS WILLIAM H. BATES (SSN680)
USS TUNNY (SSN682)
USS CAVALLA (SSN684)
USS RICHARD B. RUSSELL (SSN687)

9. Q: What precautions does the Shipyard take to protect the men who work with radiation? What medical and safety precautions does the Shipyard take? Are the men given annual physicals or periodic check-ups; what about blood tests and urinalysis; are they directed to take showers after their tour of work?

A: The Radiological Control Program at Portsmouth is an aggressive program operated under strict rules to ensure the protection of the worker. The Shipyard Radiological Control Program is directed towards minimizing radiation exposure to workers to as low as practicable through the use of strict controls on all aspects of radiation work. This includes equipment design, worker training, preplanning, working in verbatim compliance with written procedures, close monitoring of personnel radiation exposure, extensive use of radiation shielding, and containing radioactivity during work operations. Shipyard management is active at all levels to ensure the proper control of radioactivity. The Radiological Control Program commenced over a year before the first radiation work began at Portsmouth. Ever since its inception, the program has exercised stricter requirements than those in the Federal Regulations (Title 10 of Code of Federal Regulations). A brief summary of the Radiological Control Program at Portsmouth follows:

All personnel are required to receive formal training in various aspects of radiation work and in radiological controls prior to being authorized to perform radiation work. The initial training course must be completed satisfactorily in order for them to become qualified to work in a radiation area. This qualification requires satisfactory completion of a written exam as well as satisfactory performance during simulated work operations. Every radiation worker must requalify in this same manner every two years. In addition, each radiation worker must attend a "refresher" training course to formally up-date his knowledge of radiological controls at least every year. This training is performed by full time instructors of the Radiological Control Office. Training is also conducted by individual shop instructors in the specific job skills for radiation work within each trade. Periodically, training bulletins discussing radiological control matters are distributed to be read and discussed with all radiation workers.

Radiological control surveys are taken on a frequent basis by highly trained and qualified Physical Science Technicians in the Radiological Monitoring Division of the Radiological Control Office. These surveys consist of routine surveys of areas and facilities, and surveys for each individual radiological work operation performed. Surveys are conducted for radiation levels, radioactive contamination levels, and airborne radioactivity concentrations. The results of surveys and monitoring are reviewed by supervisory personnel to provide a double-check to assure no abnormal or unacceptable conditions exists. In addition, many operations are monitored continuously by radiation detectors and air samplers. The instruments used for monitoring and surveying operations are checked daily and prior to use and receive regular calibration and maintenance. Surveys provide a continuous "picture" of radiological conditions in all areas of the Shipyard.

Perhaps the most restrictive regulations in the radiological control program are established in the requirements for the control of radioactive contamination. Any work operation involving the potential for spreading radioactive contamination is carefully planned along with strict specifications requiring "total containment" to assure that no person becomes contaminated. The Shipyard's controls for radioactive contamination are so strict that the Shipyard has sometimes had to take precautions to prevent tracking contamination from "fall-out" and natural sources into nuclear areas because the contamination control limits used in the nuclear areas were below the levels of natural contamination occurring outside in the general public areas. A basic requirement of contamination control is the monitoring of all personnel leaving any area where radioactive contamination could possibly occur. Because this monitoring is complete and is to very low levels, routine showers after work is not required. The basic approach at Portsmouth is to prevent contamination, not wash it away.

Any work performed on radioactive material is performed under strict compliance with written instructions. Written instructions are reviewed by professional radiological/nuclear engineers or health physicists of the Radiological Control Office. These instructions are reviewed to ensure adequate radiological controls are contained in the instructions for the work being performed.

Because the radiological control program exists for the protection of the workers, personnel monitoring has always received a great deal of attention and is performed in accordance with the "state of the art." A description of the monitoring techniques was provided in response to question 4. Personnel monitoring at Portsmouth is directed by professional health physicists of the Radiological Control Office.

Personnel medical qualifications have always been in accordance with requirements imposed by the Navy Bureau of Medicine and Surgery. Every worker is required to take a radiation physical examination prior to entry into the radiation program as a radiation worker. If, during his employment as a radiation worker, a worker receives more exposure than that which is allowed any member of the general public, medical examinations are also given at least every three years. Every radiation worker also receives a medical examination upon termination of employment. These examinations are conducted in accordance with the requirements of the Bureau of Medicine and Surgery and do include appropriate blood tests/urinalysis and bio-assays. Monitoring for internal radioactivity is performed by a "Whole Body Monitor." This equipment is capable of detecting internally deposited radioactivity to levels a thousand times lower than allowable levels. If the medical examinations uncover any condition which may jeopardize the workers medical qualification as a radiation worker, the worker is disqualified until his case can be reviewed by the Radiation Health Effects Advisory Board of the Bureau of Medicine and Survery. This Board is comprised of physicians specializing in Radiation Health. The Board decides whether the worker may remain qualified or must be disqualified.

In order to ensure the radiation protection program is operating strictly in accordance with the requirements established by the Federal Government, the Navy, and the Shipyard, the program is audited by several organizations. These organizations consist of: (1) a Shipyard internal audit organization (the Radiological Engineering Division of the Nuclear Engineering Department); (2) Resident personnel of the Department of Energy, and (3) inspection teams from the Naval Sea Systems Command. The radiation protection program must satisfactorily pass these audits and inspections in order for the Shipyard to maintain its authorization to handle radioactive material.

10. Q: Have radiation workers ever been paid extra for their work? What incentives are offered the men, if any, to work with radiation?

A: Radiation workers have never been paid extra for radiation work. No special incentives are offered for work in radiation areas. The risk from radiation at the Shipyard is less than the risks regularly accepted in normal industrial work.

11. Q: What studies or analyses have been undertaken by the Navy or federal government to determine that frequent exposure to low level radiation does not lead to a greater possibility of cancer and/or leukemia?

A: There have been numerous studies sponsored by the federal government which have studied the relationship of the incidence of clinical disease such as cancer and leukemia and radiation exposure. For example:

(a) One of the largest has been the study of the survivors of Hiroshima and Nagasaki by the Atomic Bomb Casualty Commission. This study has not demonstrated an increase in the incidence of disease for low level radiation exposure below 50 rem. This study has been in progress for approximately 30 years.

(b) The Report of The Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR Report) by the National Research Council National Academy of Sciences titled "The Effects on Population of Exposure to Low Levels of Ionizing Radiation" reviewed the available literature on radiation exposure and biological effects as of 1972. The BEIR report states that no excess in leukemia, or other cancer, has been documented in populations exposed at dose rates within present occupational exposure limits.

(c) The Department of Energy has an ongoing mortality study among Federal civilian workers at Hanford.

Numerous other examples could be provided such as studies of the effects of therapeutic medicine radiation exposure, effects of fallout on Marshallese Islanders and effects of radium on painters of watch dials.

One organization chartered by the United States to review the scientific literature and to make recommendations on exposure to ionizing radiation is the National Council on Radiation Protection (NCRP). The NCRP in their Report No. 39, "Basic Radiation Protection Criteria" (1971), stated:

> "Experience with occupational exposure in the general neighborhood of presently acceptable limits over the last two or three decades has shown no identifiable injury ascribable to radiation."

The NCRP has emphasized that the presently permitted exposure levels represent a level of risk small compared to other hazards of life. In their 1975 Annual Report, following their review of the BEIR Report, the NCRP stated:

> "The NCRP finds no new evidence on radiation effects calling for changes in radiation standards as proposed in our 1971 report."

With regards to the risk of radiation exposure at present limits, the U.S. Nuclear Regulatory Commission has stated in NRC Regulatory Guide 8.13 dated November 1975:

> "Control of exposure to radiation is based on the assumption that any exposure, no matter how small, involves some risk. The occupational exposure limits are set so low, however, that medical evidence gathered over the past 50 years indicates no clinically observable injuries to individuals due to radiation exposure when established radiation limits are not exceeded."

The Navy has conducted screening studies to ensure no significant problems show up which would warrant deeper study by other Government agencies. One of these Navy studies covers about 56,000 Navy personnel by the Submarine Medical Research Center.

12. Q: Has there ever been or is there now going on any studies to determine the cancer and/or leukemia death rate among the men who work with radiation either at the Shipyard or any other federal facility? What do you think of the merit of such a study? Our research indicates a cancer death rate of approximately 38% among the men who have worked with radiation at the Shipyard, whereas the cancer death rate among persons there not working with radiation is 21%. (Kurkjian stated that they had examined 100,000 death records in three states and from that came out with 2,000 deceased Shipyard workers and it came down to identify nuclear/non-nuclear as 600). Is that significant difference and are you concerned about the difference?

A: The first parts of these questions are answered in 11. above. The Navy is concerned about any health effects among all our civilian and military personnel and has encouraged anyone who has information suggesting ill effects to report them to the Shipyard authorities. In your question you state that your research indicates a larger death rate among those Shipyard workers who have worked with radiation. The Shipyard would be interested in such data, thus it would be helpful if you would provide to the Shipyard the information you have on the cancer deaths of Shipyard workers. The Shipyard will have this information evaluated by Navy medical personnel.

13. Q: In the Commandant's letter to the Portsmouth Herald on 12/9/77, he stated that an analysis done by the Navy shows that no person has developed any illness caused by radiation from a Naval Nuclear Propulsion Plant. Also the letter stated that the studies show a lower incidence of various diseases, including cancer and leukemia, for radiation personnel than for the general public. Who did the long-range health study for ERDA? Identify those studies. How was the data gathered? The letter states the Navy has made studies of health records and has other studies in progress. Are these studies of radiation workers or of Naval employees in general?

A: The study mentioned in the Shipyard Commander's letter to the Portsmouth Herald on 12/9/77 was the Longitudinal Health Study of personnel assigned to nuclear submarines which was done by the Submarine Medical Research Laboratory. This study included nuclear submarine personnel of all rates, including both personnel exposed to radiation and personnel who were not. Many of the personnel exposed to radiation performed work similar to Shipyard employees. The Navy also has other studies in progress. These include mortality studies of Shipyard personnel including personnel who have received radiation exposure. Although they were not started specifically to look at radiation effects, they would identify high mortality rates from radiation exposure.

14. Q: Did the Navy study the health of the workers over a long range of time, or was it a study of their health at the present time? Has any study tried to determine what the cancer and/or leukemia death rate was for employees who had worked with radiation over an extended period of time, so as to take into account the extended gestation period for cancer to develop?

A: Yes, there is an ongoing study at the Naval Submarine Medical Research Laboratory of all retired Navy personnel who have served on active nuclear submarine duty.

15. What are the reasons the Commandant of the Shipyard declines to be interviewed in person?

A: The Shipyard Commander does not conduct general interviews on this subject because the subject matter is highly complex and can easily be misunderstood and consequently misquoted.

16. Q: Was there an incident during the original overhaul of the NAUTILUS in which a small group of men were exposed to radioactive primary system water when a hose let go spraying the radioactive water among the men? One of the men who said he was present at the incident was Ronald BELHUMEUR of Dover, NH, a retired Shipyard laborer. According to your records was MR. BULHUMEUR present and/or exposed to radiation in any such incident? If he was, provide me with the circumstances of the incident, the names of other men involved, the measures taken to measure the radiation doses each man received, the measures taken to cleanse them, and the measures taken to determine if there were any lingering effects from their contaminations. MR. BELHUMEUR is willing to provide me with a release, if necessary, for the info, if it falls under FIA or PA requirements.

A: Although an event similar to that which you have described may have occurred during the NAUTILUS overhaul, review of the summary records of the overhaul shows there were no occurrences which could have resulted in any detectable radiation effects on personnel.

Mr. **Rogers**. Thank you very much, Dr. Najarian, for sharing with the committee this important information.

Senator Hathaway?

Senator **Hathaway**. Thank you very much, Mr. Chairman.

Mr. **Rogers**. I think we will use the 5-minute rule.

Senator **Hathaway**. Doctor, let me ask you just a few questions about your study itself. I would take it from what you said that you would provide a lot more information. Would it be a fair statement to say your study really is not complete?

Dr. **Najarian**. Well, the study as I have done it, is complete. In other words, according to the methods that we used the study is completed, it is not going to go any farther than it is now. The study could be a different study and could be perhaps an even better study if we had had complete information as to all nuclear workers, when they did their nuclear work; what their radiation levels were, and that sort of thing. But even the list of all the nuclear workers would be a useful thing.

However, I would like to say that I do not blame the Navy for not giving me that information, I was not working under any official grant, and I do not think they would feel it appropriate to release that sort of information to any private citizen who just happens to say he is doing a study on the Portsmouth Naval Shipyard. I never expected that they would release that information, and I do not think that is something an agency would ordinarily do.

Senator **Hathaway**. What additional information would you need that would change your conclusions, or could change your conclusions?

Dr. **Najarian**. Well, this was a proportional mortality study, which simply means we look at deaths and say what percentage died of various causes. There could have been a very significant radiation effect taking place that would not have been picked up by a study of this kind. For example, if people died of both heart disease and cancer in the same proportion that they die at older ages, but die, say, 20 years younger, this kind of a study could not have shown any effect at all. It would show that the proportional mortality, in other words, the percentage of deaths from cancer would be the same. If another study were done, the appropriate study should be a cohort study, which would be to follow every single person who has ever worked, say, at any particular shipyard. And again, I would emphasize, I do not believe that this particular shipyard is any different from the others in terms of their procedures. I have a question to that effect that I would like asked of the Navy. I do not believe there is anything unusual going on there, nor that they violated any safety standards, or accepted radiation levels for occupational exposure.

I think that everything they did they believed to be within the realm of accepted safety.

What I am saying, the appropriate study should be to look at all people—living and dead—in order to be able to calculate age-adjusted mortality rates and compare those with both the working population at the shipyard who are not involved with radiation, and perhaps with the general U.S. population.

Senator HATHAWAY. When you make the comparison, do you make it on the basis of age groups?

Dr. NAJARIAN. The final paper is an age-specific proportional mortality, and it shows something that I am really not sure of why, but if a person died in his sixties, then the chances of his dying of cancer, if he died in his sixties, was nearly 60 percent, 59.5 percent was the final figure. There were a lot of deaths in that particular age group, so that figure was highly statistically significant, compared to the nonnuclear workers which, I believe, had 26 or 27 percent dying of cancer. I have to consult my paper, I am not exactly sure.

Senator HATHAWAY. Also, your comparisons were on a national average and did not pick up particularly localities. I am thinking particularly, I think Maine has the third-highest cancer death rate in the country. Might that have affected it?

Dr. NAJARIAN. Well, the actual differences between one state and another are very, very small. There might be an overall percentage of cancer deaths, let us say, in Maine of 19.5 percent, where the whole U.S. average might be 18.6 percent proportional mortality. You are talking about a difference between 18 percent or 19 percent, let us say, for all age groups in different States as compares to 50 percent or 60 percent cancer deaths in the study population for certain ages.

In addition to that, the population in Maine, and New Hampshire, is small enough that it is conceivable that a very high number of cancer deaths from a point source such as the Portsmouth Naval Shipyard, for leukemia, could actuall affect the overall statistics for the entire State a very small amount. Now, I doubt very much that that is the effect because the working population of the shipyard may represent one one-hundredth of the population in New Hampshire, or slightly less than that. So, I do not really think that could be a factor.

There are also differences on how deaths are rated, according to doctors. In other words, how a doctor fills out a certificate, and how registrars rate them in various areas, there might be conceivably slight differences that could alter statistics that way.

Senator HATHAWAY. What further studies do you think there should be made?

Dr. NAJARIAN. Well, I think this particular group, the shipyard workers across the country represent a good group to study because the records are available, as I understand it, how much radiation they received and when; and the fact that you have an internal control. In other words, with people employed in the same facility who are not doing radiation work, you will be able to get a clear separation between what you would presume to be a radiation effect. You might also look at other factors in the environment that could be, conceivably, interacting with the radiation, such as asbestos exposure, or solvents, or whatever.

I would think that perhaps looking at this shipyard and maybe one or two others, selected at random, would give enough data to make some sort of conclusion as to the actual risk at the shipyard.

Senator HATHAWAY. I have a few more.

Mr. ROGERS. Go ahead.

Senator HATHAWAY. Could you give us just a brief analysis of what is the causative factor of radiation to cancer?

Dr. NAJARIAN. I do not know. If you have someone that knows, I wish he would tell me. It is one of those things that is just an association, there are theories as to why it would induce cancer, but there are as many theories as there are people and no one really knows.

Senator HATHAWAY. How effective are radiation badges, are you familiar with that?

Dr. NAJARIAN. Well, this is one of the points that I am sure could be settled by this, and that is that the previous studies took some calculated rem dose, let us say the studies on medical X-rays, people who received radiation, or the atomic bomb survivors. They took a rem dose, and in the case of the atomic bomb survivors it was based on the blast radiation itself. What they figured was, if they were a certain distance from the center of the blast, for example, they would have been exposed to a certain amount of rem's from gamma rays and neutrons mostly, from the initial blast itself.

There is also the fallout, and another type of radiation, involving neutron activation. Basically they figured from the measurements they could make that the fallout was so low compared to the overall blast radiation that the fallout itself could not have contributed to any disease. I have checked this out with Dr. Jablon and others, it has never really been carefully studied, the actual effects of the fallout. One reason was, they did not know where the fallout went, although there was an area in Nagasaki that was heavily hit by fallout. I have a report that was just given to me yesterday that states that researchers have only basically been able to interview 50 people from that area, which would not be enough of a sample to conclude anything.

But I believe that the fallout or particles, in other words, they become radioactive. When they get internalized, they perhaps are causing a lot more damage than the actual measurement that one would make by a radiation detector, walking through an area of fallout. Once something gets internalized it would include some beta emitters, possibly, or gamma emitters; and this internalized radiation may be causing a lot more disease.

That might explain in part why at Smokey, where they were exposed in some cases to fallout only, and the REM counts were supposed to be only one or two REM's or less, that may be one reason why they are getting so much extra leukemia because the fallout may in fact be causing a significant portion of the cancer and leukemia. That is just a hypothesis, and it would help explain perhaps why in the shipyard environment where they actually work with radioactive materials, there is radioactive dust in the air at times, a room may become contaminated or they may come in contact with water that is contaminated, that the internalization of that material may in fact be causing more damage than those badges are measuring, the external detectors.

Senator HATHAWAY. Thank you, my time is up. Thank you, Mr. Chairman.

Mr. ROGERS. Dr. Carter?

Mr. CARTER. Thank you, Mr. Chairman.

What types of leukemia have you found in shipyard workers?

Dr. NAJARIAN. Well, a lot of the leukemias were just unspecified, they said acute leukemia; there was acute lymphoid leukemia; there were several cases of chronic myeologenous leukemia; there was one CLL, a person in his sixties. About half of them were just acute leukemias, they were unspecified. There were several acute myeologenous, and one chronic lymphocytic.

Mr. CARTER. Then we get the idea that although there is a proven relationship between radiation and leukemia, there is no relationship between radiation and any particular type of leukemia; is that correct?

Dr. NAJARIAN. Well, from the previous studies it is felt that most commonly chronic myeologenous leukemia going on to acute myeologenous leukemia is the most common form of leukemia. There is also a slightly higher incidence of acute myeologenous leukemia in previous studies. In general all cancers are increased by radiation exposure, provided that the appropriate organ gets exposed.

Mr. CARTER. But to say that a particular type of leukemia was not caused by radiation, we could not just specify that; could we?

Dr. NAJARIAN. Well, no. You cannot specify that any one single case of leukemia was caused by radiation. I would like to say something, though—and this has never been looked at—there is a new type of leukemia that has been described; it is not exactly like a leukemia, it is a little bit different, and that is the so-called hairy cell leukemia, which Mr. Pohopek has. We have five patients in our hematology clinic now with hairy cell leukemia, and I believe that one or two of the others also had heavy radiation exposure. It is something that was probably present through the years but was never really described because it took an electron microscope picture to make the diagnosis. It was probably present before.

There is no set disease that you can pinpoint, that was caused by radiation and nothing else.

Mr. CARTER. We have known of hairy cell leukemia, I believe, since 1958, have we not? And the electron microscope has been available only a very short time.

Dr. NAJARIAN. It was probably present before.

Mr. CARTER. In the course of conducting your interviews with the families of shipyard workers, did you discover any reports of unusually high exposure to radiation?

Dr. NAJARIAN. Well, it seemed to be a stoical part of the workers, that the workers never discussed very much with the families as to what actually went on. I believe that there were, from what people tell me, a lot of small so-called incidents—I do not know exactly how frequent they are—where something that contains contamination is spilled, or spread on a small area, or whatever. That is one of the questions I asked , too, of the Navy, how frequent are these small incidents. I do not have any report of an accident that would result in enough radiation to kill someone outright, or within two or three weeks after the exposure.

I would like to say that this accident, by the way, that a number of people have told me and the Boston Globe, occurred, I believe, in 1960, involving the breaking of a water pipe, and that there were two leukemias from that, two cancers out of the six people, one other death.

In that accident two of the people who were involved in it had total radiation counts reported by the shipyard, one Mr. Belhumeur, who will be speaking here in a few minutes, I believe less than eight rem; and the other is someone else who was less than five rem, his total shipyard exposure.

Mr. CARTER. In the cases you've examined have you found that there are more cases of hairy cell leukemia than any other particular kind?

Dr. NAJARIAN. No; there was no case of hairy cell leukemia in this group. In fact, I would doubt very much——

Mr. CARTER. I thought you said that the gentleman you are treating at the VA has hairy cell.

Dr. NAJARIAN. He has hairy cell, but he is not part of the study.

Mr. CARTER. He is not part of the study, but he was a worker there?

Dr. NAJARIAN. He was a worker there, yes. That is a diagnosis that I do not think would have been made, and even now would be made with great difficulty. In fact he had been studied, this particular patient had been studied for a while at the Exeter New Hampshire Clinic, and they did not have the vaguest idea of what he had. In fact, it took us 2 to 3 weeks to figure out what he had.

Mr. CARTER. Could you elaborate on your preliminary finding that the workers exposed to radiation at Portsmouth may be facing an early death?

Dr. NAJARIAN. Well, again, the kind of study that was done, you cannot prove that they are dying younger. However, when you look at the ages at which people are dying in the nuclear and the nonnuclear group, if you just take, for example, people who die at less than age 50, the nuclear workers may in fact be younger than the others. There were just as many workers dying at less than age 50 among the nuclear as compared to the nonnuclear group; and this was not put in the study, but it was part of a separate analysis. I could make that data available once the study is published. But there were just about the same number of workers in the nuclear group dying at less than age 50 as in the nonnuclear group, despite the fact that there are a much smaller percentage of nuclear workers.

Again, this is an issue that I think is important. The Navy has stated that there is no clear evidence that any other disease other than cancer is caused at an earlier age, or rather occurs at an earlier age from radiation exposure. However, there is a lot of information from animal experiments that talk about a general shortening of life expectancy from radiation exposure for all causes, and a major study which was referred to in the BEIR report by Saltwell and Saltzer also shows American radiologists had a higher cardiovascular renal death rate from radiation exposure—rather the people they identified as a high radiation exposure group had a higher death rate compared to other medical specialists, as well as having a higher death rate of cancer.

Mr. CARTER. How would you describe the response of the Navy to your work?

Dr. NAJARIAN. Well, if I were them, I would have responded even harsher.

Mr. CARTER. Sir?

Dr. NAJARIAN. If I were the Navy, I would have responded ever harsher. You know, there are a lot of limitations to a study done in this manner and with this technique. However, I feel that there were so many leukemia deaths, and there was such a big difference between the nuclear and nonnuclear, that even if there was a bias, a small bias, it would be highly unlikely that the bias could have caused such big differences; either a reporting bias from the people who said their next of kin had radiation exposure, or whatever.

Mr. CARTER. Thank you, Mr. Chairman.

Mr. ROGERS. Thank you. Mr. Markey?

Mr. MARKEY. Thank you, Mr. Chairman.

In one of your earlier statements you were saying that you do not blame the Navy for not letting any old citizen get hold of that kind of information. I guess that is the very reason that we passed the Freedom of Information Act, so that any old citizen can find out what his government is doing. Especially when a respected doctor and a nationally respected newspaper asks for information which will make it possible to decide what effect indication is having on the public and upon individuals who are working within Federal facilities, this is a very legitimate claim.

Dr. NAJARIAN. Well, we did not exhaust all the appeals that were available, there are only so many resources that I had available.

Mr. MARKEY. I can understand that you did not exhaust them, but it is dismaying to those of us that are interested in seeing not only the letter but the spirit of that law complied with, that the Navy was not as forthcoming with information as they could have been.

What I am wondering is, in light of your inability to come up with all the documentation which you wanted, what do you say to the Navy's contention that your study and the Globe study is not credible because of the weight of evidence from numerous other studies, which they never cited. I guess, to contradict you; and that your simplistic approach really lends itself not to the kind of credibility which a scientific research should.

What do you feel about these criticisms, and the attacks upon the limitation of your study. Should we be able to give any weight to your study, and what kind of weight should we give it?

Dr. NAJARIAN. Well, first of all, some of the best studies are the most simple studies, the ones that do not have to be so complicated because the effect is so obvious. It was a very simple approach, I admit that. There are certain hard things, like the number of leukemia deaths, and the fact there was such a wide difference in percentage of cancer deaths between nuclear versus nonnuclear workers. And the sample was a very highly statistically significant sample.

Mr. MARKEY. Do you think your sample was statistically significant to the point where it can withstand scientific challenge?

Dr. NAJARIAN. Well, the statistics can withstand scientific challenge. But again, more important than statistics is what went behind the study itself to bring those results. Now, I tried in analyzing the data as much as possible to in fact bias the study to show no effect. Just to give you an example, these four cases where the family said they died of cancer, I did not get the original records because for epidemiological research that is not an accepted thing. If you decide to set up a criterion for something, you use that for the whole group.

In addition to that, I went very strictly by what the Globe reported to me. We went over the data later, in other words, the answers to the questions they had asked the next of kin. By their answers I had a set criterion as to whether I would call them a "definite exposure," a "probable exposure," a "did not know," or, "no." It turns out that the definite exposures and the probable exposures both had roughly the same percentage of leukemia and cancer in each of those groups. So, I felt there was no particular bias in someone saying, "Well, I think he was exposed," when in fact he was not.

When I went over the data with the Globe there was one case with a multiple myeloma that the way the Globe had written the statement, it sounded like it was not a radiation exposure, but in fact the person who took that particular phone call said he remembered distinctly that that was a radiation-exposed person, but he had just not written it down the way that I would have picked it up if this was radiation. But I did not change that, I kept it in the nonradiation group.

In other words, I was very strict because I know this was an important thing and we would be held up to criticism, and it is going to be repeated. Either the facts are going to be there, or they are not. I believe very strongly they are going to be there. I do not think that anyone should be settled with just this study and say, "Call it a day," or whatever.

There are a lot of other things that have to be done to identify exactly what is the risk. Perhaps it is only a risk because of something that happened in 1960. It is quite possible that all the effects we are seeing here could have been from something going on, perhaps a number of radiation accidents that were not reported, or whatever; but a high radiation exposure occurring in 1959 or 1960 could have carried through this whole time period. Anything they would have done in the last 10 years to make the standards better, or safer, would not show up in a study like this.

Mr. **Markey**. Let me ask you, how did you determine how much radiation these people had been exposed to, did you use conservative estimates?

Dr. **Najarian**. Again, we tried to put estimates on this, but we did not know specifically for a specific person how much radiation that person received. What we did know, I received some information from George Hutchinson at the Harvard School of Public Health. The Navy had reported—and I do not know where this was published—but Dr. Hutchinson had a sheet that stated that the average radiation exposures for the 55,000 or so Navy personnel who are monitored for radiation, which would include people within the actual boats themselves and shipyard workers, and some other people.

In this group there was a remarkable consistency between, I think, 1969 and 1973, that 90 percent of the people received less than one rem per year in their group; 95 percent of the people received less than two rems. No one received more than five rems during that entire time. I believe no one exceeded three rem per quarter, according to the Navy, during those 4 years.

In addition to that, in a study referred to, a published report by the EPA, which gives an average figure for Navy personnel exposed to radiation of 0.211 rem per year. This is for the industrially exposed people, and not the medically exposed people, which is lower than that. For the industrial an average of 0.211 rem per year. If you take that average and say, well, you have 10 years of radiation work, that gives you about 2 rem for radiation work.

Now, in conjunction with the study I also interviewed a number of people, and I have actual records from the Navy, as to actual radiation amounts. I had three cases of leukemia where I know the radiation exposure, according to the military, was less than 10 rem. In addition to that, of all the people I interviewed one person has said that his radiation exposure was 40 rem; his was the highest of anyone who told me. This was again a total lifetime exposure.

Mr. MARKEY. Well, among the people that you surveyed, there is always the problem of averages. You know, the average depth of a swimming pool can be 5 feet, but if 10 percent of the people go down to the 10-foot depth, there is a greater danger for them, clearly.

There have been people who testified before the subcommittee over the past couple of months who have indicated there ought to be a reduction to one-tenth of what the current acceptance level of radiation exposure is, which is apparently five rems. Do you agree with that?

Dr. NAJARIAN. All I can say is these people are receiving, I believe, much smaller doses of radiation, if in fact the radiation records as reported to the workers themselves, and on sheets handed out by the shipyard are correct, that they are in fact receiving much less radiation than would be needed to account for effects of this kind. Now, it could be that there are other factors interacting with radiation, that are doing this; that it may not be just the radiation itself.

I do not know, I could not make a statement like that based on our study because you need a lot more information before you can say that. It could be that the effects we are seeing are occurring because of a very small group that were involved in very high doses of radiation exposure, that are causing this disease.

One of the persons that was exposed in that accident in 1960 showed up in the study; the other one did not, just because of the random method that we got the death certificates. One of the leukemia deaths, I am talking about. So, it could be there was a very small population getting high amounts of radiation, that caused these results. I could not say that from a study of this kind, but I think a study could be done.

Mr. MARKEY. Do you think there are other occupational carcinogens which they could have been exposed to, which could also give similar results in such a study?

Dr. NAJARIAN. There are no other carcinogens that could have accounted for this result alone for the simple reason that the nonnuclear workers who were exposed, I believe, to the same types of materials except for radiation, those people did not have a higher proportional mortality of cancer and leukemia. It is possible, however, that in combination with radiation something else is causing a very high incidence, similar with what happens with asbestos exposure and cigarette smoking. Asbestos exposure in and of itself does not increase the incidence of lung cancer by any great degree, but if you throw in cigarette smoking, it multiplies the effect manyfold over just the asbestos itself.

Mr. **MARKEY.** Thank you, Mr. Chairman.

Mr. **ROGERS.** Mr. Walgren?

Mr. **WALGREN.** You are an employee of the Veterans' Administration?

Dr. **NAJARIAN.** Yes.

Mr. **WALGREN.** And why did they say you could not get any outside funding whatsoever if you wanted to pursue this interest?

Dr. **NAJARIAN.** Well, as I understand my contract there we are not allowed—although a lot of fellows and residents do this—to take so-called moonlighting jobs. We are not allowed to work other than our work at the VA and earn money at it. There are a number of people that do that, I do not. It is part of the contract that we are not allowed to be salaried by any outside agency, or work, or employer, whatever, as long as we are working at the VA.

Mr. **WALGREN.** I see. What reasons did the Navy give for refusing to disclose whether or not deceased workers were involved in nuclear or nonnuclear work?

Dr. **NAJARIAN.** I can read their replies.

Mr. **WALGREN.** Have those been entered in the record?

Dr. **NAJARIAN.** I think you have a copy of all the letters that they sent me.

Mr. **ROGERS.** I think it was submitted for the record.

Mr. **WALGREN.** Well, if they are in there——

Dr. **NAJARIAN.** Basically they quoted the Privacy Act, that was their major reason; the privacy of the individuals.

Mr. **ROGERS.** Excuse me, of the deceased individual?

Dr. **NAJARIAN.** That has not been written, that was verbal over the phone. The Boston Globe team asked them after they turned down the last request, which was for names only, asked them if we had submitted to them a list of people who were deceased. The fellow—I do not know whether he was trying to be funny, or whatever, it was not a written reply—he said they would not give that either because of the Privacy Act. I suppose maybe the privacy of the families, or something.

Mr. **WALGREN.** And when you inquired at the Portsmouth yard, did you find there was any current study of health effects ongoing?

Dr. **NAJARIAN.** Well, part of the statement that they released to the Portsmouth press contained what I considered a misleading statement, that they had studied 56,000 people and found a lower incidence of cancer and leukemia. I guessed at that time that must not have been a followup study, and it turned out I am correct, it was not a followup study. There are no studies, basically, no followup studies, unless they have done their own privately and have not released the information, which I doubt. None of the doctors are aware of any studies, and I called several other shipyards and talked with them, and they are not aware of any studies of this nature.

Mr. **WALGREN.** From your involvement with this project, can you suggest what should go into a study that would satisfy you on whether or not there are harmful health effects, and what the risks are?

Dr. NAJARIAN. Well, I think the CDC or any other agency that does this sort of research would know exactly what to do, and what information to get. I am sure I would be satisfied.

Mr. WALGREN. Why does everybody have such great confidence in the CDC?

Dr. NAJARIAN. Well, can you tell me any case where they have ever falsified or hid the result of some study? I do not know of any. I know of no reason to question their honesty.

Mr. WALGREN. No; I have no reason to question their involvement in any way, except it strikes me that this is an extremely sophisticated area. I understand the CDC has undertaken some statistical analyses, but I have no indication that the CDC has people who could accurately evaluate, or sensitively evaluate, what must be extremely complex data. Maybe they do, but I just notice there is a great rush to say that the CDC alone should be able to pass judgment on this.

Dr. NAJARIAN. I would like to say that there is a tumor registry in New Hampshire—the name of the fellw involved, I think, is Ross McIntyre, no relation to Senator McIntyre—who apparently have some sort of records of all tumors that occurred in hospitals in New Hamsphire. They might be able to assist whoever will eventually do the study; they might be of assistance in some way.

Mr. WALGREN. Part of my problem is that it is such an emotional area that certain people do not give credence to other people's viewpoints. That, I take it, is why you prefaced your remarks by saying that you in fact believe that nuclear power was a reasonable thing under certain circumstances. That is a very interesting disclaimer. I am concerned that we really are satisfied with whom will conduct the research in the agency and what kind of balance the group has that is finally brought to bear on this. Otherwise we will be subject to the same kind of disbelief about this study.

Dr. NAJARIAN. Well, I do not think it is likely that any study which is done honestly from records that are available will show there is no effect on the nuclear workers. But I must emphasize that you are talking about a very small proportion of workers within the shipyard itself—I do not know exactly the number of nuclear submarines at this time, there used to be 92 a few years ago. But they are overhauling a large number of nuclear reactors, and I presume conditions might be a little more difficult because of the size of the submarines to maneuver in, than perhaps, say, a standard power plant.

There is risk in any kind of energy production in this country, especially to the workers involved. There is risk even to the general public for burning coal or any other fossil fuel, and these risks may be far greater than any risk to the general population from nuclear power reactors.

I am talking about only the risk to a small group of people who actually get involved in having to repair radioactive areas. When you compare this risk, say, to coal mining or other risks of getting other forms of energy, it may in fact be that it is no different from those others.

But I think it should at least be looked at to see if there is any way that the health can be improved for these people.

Mr. WALGREN. I would simply like to add that when witnesses come before the committee and talk in terms of risk, we are not talking about a risk to the individual; but a certainty of death to a number of people involved in a large population. What we are talking about is the certainty of death, not the risk of death, at least in to the overall group.

Dr. NAJARIAN. Again, if you talk about proportional risk, you would talk about an average loss of life expectancy of nuclear workers as compared to some other type of worker. You could say, yes, some particular person is going to die at age 55 of cancer, or age 62 of leukemia. But you cannot predict who those people are going to be.

But if you can say that the overall risk is a given amount for the average worker who is actually doing that particular work, you can compare it to other risk and say whether or not it is something that should be improved.

You have to realize that a lot of people in this country accept the risk of cigarette smoking which shortens their life expectancy by maybe 8 to 10 years in the average. That, to me, is a very, very big risk. And yet, millions of people accept it.

Mr. WALGREN. Perhaps the reason they accept smoking and do not change their own habits is because we continually describe it in terms of, "Well, it is just a risk to you." We do not really come to grips with the fact that we are talking about a certainty of death to a number of people in a given group. Now, it may not be you who dies, but someone is going to die. When we just say, "Well, it is just a risk", it may very well be that people think, "Well, gee, if it is just a risk that means that maybe it will, and maybe it will not." But it will, and that is the point.

I have one other question.

Mr. ROGERS. Go ahead.

Mr. WALGREN. I would like to leave the record open at this point and ask you if you would submit what you feel should be looked at in a study to get at what you have tried to get at, at Portsmouth. I do not know what kind of a group we will come up with in the long run, or who will appoint the group. But I would like to see that group responding to the specific parameters that you believe should be examined. I would like to leave the record open at this point for a submission, if you would.

Dr. NAJARIAN. I will try to get something together, I can mail it to the committee.

Mr. WALGREN. Thank you.

Mr. ROGERS. Let me just ask a couple of questions, and then we will go back to other members.

From your work, would you believe that workers received more than measured or stated radiation exposure; would there be any way for you to make that judgment?

Dr. NAJARIAN. No.

Mr. ROGERS. Well, what about the possibility of internal radiation, such as alpha and beta?

Dr. NAJARIAN. Well, again, they measure internal radiation in certain ways, they take whole-body counts, and what not. I do not know enough about the details of what they do to state whether or not they are measuring everything they should be measuring.

I would also like to point out that no one has really done a study that relates a measurement of internal radiation—at least I am not aware of any—some sort of measurement to disease later. There are studies that rate so-called REM count to the predictability of disease later. But I am not aware of any, except possibly Mancuso's, which I really have not completely gone over, that take some kind of measurement of an internal radiation. In other words, taking the measurement and actually using that measurement and converting it to an external detector or REM-count measurement, and then predicting the amount of disease from that. I do not think there is any study that actually tries to say, all right, if the internal detectors say this much, whole-body counts, or whatever, this is what we would expect.

Mr. ROGERS. Our staff, in talking to workers at Portsmouth were told that there was a concern over losing jobs if they discussed this because of all this radiation publicity. I wondered if you had been given the same impression.

Dr. NAJARIAN. Well, again, I do not have any written proof for you about anything that I am about to say, but first of all, I am pretty fearless, I think. When I first started this project and did not get any replies from letters to Kennedy and Carter initially; and then I started getting replies from these questionnaires, the rapidity with which the VA was notified after the questionnaires were mailed out, it must have happened so fast—and nothing in Government usually occurs that rapidly in response to something—that it frightened me a little bit. Maybe a major effect was going on that they may have known about and did not want anyone else to know about. I was just afraid to be holding that information myself. I received questionnaires from various people. So, I myself was afraid.

There was a meeting held on December 7 in Dover, and one of the persons who was at that meeting I spoke with later, he told me that everyone who went to that meeting was questioned by the shipyard. At least he believed that everyone was questioned. Just the fact that the shipyard was interested in knowing what was said and who was there can be an intimidating factor to a number of people. You know, they do have their jobs there, and it is a vital employer in the area.

Mr. ROGERS. Could you let us have those names for the record?

Dr. NAJARIAN. The name of the person that spoke to me after the meeting was Mr. Charles True.

Mr. ROGERS. Now, what about the VA? Who contacted you on behalf of the VA to explain the concern and make the request that you furnish all papers to them?

Dr. NAJARIAN. Well, the request for the papers was a verbal request from Dr. Amick's office at the VA; he is, I believe, the director. They have a number of different categories of directors.

Mr. ROGERS. Yes.

Dr. NAJARIAN. His office requested those things. The people who talked with me were both his office and Dr. Daniel Deykin of the Medical Service, who in fact encouraged me, said I should pursue this if I felt up to it; the chief of the Medical Service at the VA.

But he did say that they wanted to make it clear to me that I was on my own.

Mr. ROGERS. I notice in your questionnaire that you sent out, you did ask, "Would you give permission to obtain your past work health and radiation records at the shipyard?" Did you get positive responses to that question?

Dr. NAJARIAN. Yes; everybody that returned the questionnaire they all did give me permission. There may have been one that said, "No."

Mr. ROGERS. Did you use that?

Dr. NAJARIAN. No; I did not because, again, this data that I collected in that manner I merely used as a screening technique in order to see if there might be a problem. None of that data was used in the final study because it was not randomly collected data, it was selected data. It was simply put aside as another body of data.

Mr. ROGERS. And could you set forth for the record—and I will not ask you to do it now but in writing—what type of data you would need to do a complete study which would satisfy you as a scientist?

I want to say, too, that I am very impressed with your dedication from one case to be willing to devote your time and spend your own money trying to initiate a study. The committee is appreciative of the fine work you have done.

Senator Hathaway?

Senator HATHAWAY. Thank you very much, Paul.

I just have a couple of additional questions, Doctor. What protective measures could you take against radioactive dust that could be inhaled into the body through cuts and bruises?

Dr. NAJARIAN. As I understand it, they do not allow people with cuts to go in there, but that does not mean you could not get something on your skin and it would get in through a crack or a pore in the skin.

I do not know enough about what they are doing now to be able to tell you what measures they should be doing in the future, but if it became apparent that radioactive dust in the air may be contributing significantly to the problem, then there are a number of alternative things you could do. For example, if you had older people doing radiation work, people over the age of 50, the effect would not be as severe, I would guess, than if someone did the work in their twenties.

Another thing, I suppose a possibility would be to have some sort of wholly enclosed suit for a person to wear, including an outside air system in a tank of some sort, that would then be taken off and disposed of—not disposed of, but kept aside to be used only when a person was working in a very heavily contaminated area.

I do not know enough about what they are doing now to be able to answer that question.

Senator HATHAWAY. Is there any way to detect internal emitters?

Dr. NAJARIAN. Internal emitters, you can detect them in a number of ways. First of all, some internal emitters are excreted in the urine, and depending on the time of exposure, you could measure the excretion rate and get some idea there. For autopsies you can actually grind up a person's body and scan the material for alpha emitters as well as for beta emitters. You cannot pick up any alpha emitters or beta emitters from any external scan because they do not penetrate human tissue. The external scans would pick up only gamma-ray emitters.

Senator HATHAWAY. Can their effect be neutralized?

Dr. NAJARIAN. I believe that once the radiation has been deposited in the body, I do not know of any way myself of getting it out.

Senator HATHAWAY. Will the emitters hurt another person that came in contact with that person?

Dr. NAJARIAN. No. No; I do not believe so because, again, if you take a scan—this can be known very certainly, these people are not in any way going to harm anyone else that they are near. If you took a scan of someone's body, you can measure the amount of radiation coming from their body. The amount that you are able to detect is a very, very low amount. You can detect low enough amounts, in fact, if there were some fallout, you could pick that up easily. In addition to that, stone buildings emit radiation simply because there are radioactive materials in the buildings. You can be walking by these.

Just coming in contact with radiation, especially if you are talking about very low levels that would be picked up by some external scan, that would not be harmful to someone else walking around that person. For example; just to look at the other shipyard workers, none of the other shipyard workers had any increased incidences, and they were presumably coming in contract with the people that were contaminated, from time to time.

Senator HATHAWAY. Just one last question, Paul, if you do not mind.

Mr. ROGERS. Certainly.

Senator HATHAWAY. Your conclusions are based on, I think you said earlier, average exposure. But I think it would make a difference if you got a three-rem exposure in a matter of a short period of time, than if you got it over a long period of time.

Dr. NAJARIAN. Well, you know, there is experimental data on high doses of radiation over short time, and what data there is seems to suggest that in fact, if you spread it out over a longer period of time, it is supposed to have less of an effect, for a given amount of radiation.

Senator HATHAWAY. Right.

Dr. NAJARIAN. Than if you got 10 rem all at once, that if you spread it out over many days, then it is supposed to have less of an effect, in animal studies and other human data, than if in fact you got it all at once.

Senator HATHAWAY. So that some of the conclusions you came to might have been caused, as you mentioned earlier, that maybe some accident occurred at the yard that you did not know about. A lot of people were exposed to 10 rem, or greater, at one time.

Dr. NAJARIAN. There are a lot of different factors that could be causing these results. There is a lack of information about the original exposures. I would think, though, that the fact that there were so many extra cancer deaths, that unless a significant portion of those who are involved with radiation must have been involved with accidents or something more than what is actually reported, in order to get that result. It could not be a very tiny population causing that much of a result unless, you know, it just so happened that everyone who has gotten heavy exposures already died, and all the people who are living never did.

Senator HATHAWAY. Thank you.

Mr. MARKEY. One final question, Mr. Chairman.

Mr. ROGERS. Yes, Mr. Markey.

Mr. MARKEY. There was a letter from the Navy to the employees at the Portsmouth Shipyard in the aftermath of this publication in the Boston Globe, telling them that they need not worry about the results in your study, that their own indications are that they are as safe, or safer than other employees working in this kind of enterprise. What would you say to these employees right now?

Dr. NAJARIAN. Well, I feel bad for the employees. I feel bad because they must have a lot of uncertainties about a lot of things. You know, I would like to be able to explain to them what these findings mean. They do not mean as much as some people have attached meaning to them. It does not mean that they will be dying much, much younger than anybody else. It just may mean that when they die, they die of cancer. The appropriate study has not been done to tell them exactly what kind of risk is involved. I think there is an effect that is taking place, but what that is you cannot tell from a study like this.

As far as comparison with other industries, again, there are a lot of things that people do, such as smoking, driving an automobile fast while drinking, that in fact may be more risky than what the workers are exposed to.

Mr. MARKEY. Those are self-imposed, not industry-imposed risks. People make those voluntary judgments. We have a case here where people have entered into a relationship where they may not have been told what the risks are, and indeed, they have been misled; whereas with the automobile and the cigarettes, just the opposite is the case.

Dr. NAJARIAN. I do not think that anyone, especially years ago, knew what the risks were.

Mr. MARKEY. Thank you, Mr. Chairman.

Mr. ROGERS. There is a call for a quorum. Thank you, Dr. Najarian, for your helpful testimony. We will be in touch with you as we proceed.

The committee will stand adjourned until 1:30, at which time we will hear from the Navy.

Dr. NAJARIAN. Thank you, Mr. Chairman.

[Whereupon, at 12:15 p.m. the subcommittee recessed, to reconvene at 1:30 p.m. on the same day.]

AFTER RECESS

[The subcommittee reconvened at 1:30 p.m., Hon. Paul G. Rogers, chairman, presiding.]

Mr. ROGERS. The subcommittee will come to order, please. We are continuing our oversight hearing on the health effects of radiation, and we have witnesses from the Department of the Navy this afternoon, whom we welcome.

Everett A. Pyatt, who is the Deputy Principal Assistant Secretary of the Navy for Logistics; accompanied by Adm. H. G. Rickover, U.S. Navy, deputy commander for nuclear power, Naval Sea Systems Command; Murray Miles, Director of the Nuclear Technical Division; Capt. W. D. McDonough, commander of the Portsmouth Naval Shipyard; and Capt. J. C. Rivera, Director of the Division of Undersea Medicine of the Bureau of Medicine and Surgery.

We welcome all of you to the committee and appreciate your presence. We will make your statements part of the record in full, and you may proceed as you desire.

STATEMENTS OF EVERETT A. PYATT, PRINCIPAL DEPUTY ASSISTANT SECRETARY OF THE NAVY (LOGISTICS), DEPARTMENT OF DEFENSE; H. G. RICKOVER, ADMIRAL, DEPUTY COMMANDER, NUCLEAR POWER NAVAL SEA SYSTEM COMMAND, U.S. NAVY, ACCOMPANIED BY MURRAY MILES, DIRECTOR, NUCLEAR TECHNICAL DIVISION; WILLIAM D. McDONOUGH, CAPTAIN, PORTSMOUTH NAVAL SHIPYARD; JULIO D. RIVERA, M.D., CAPTAIN, DIRECTOR, DIVISION OF UNDERSEA MEDICINE, BUREAU OF MEDICINE AND SURGERY

Mr. PYATT. I would like to read a portion of my statement, if I may.

Mr. ROGERS. All right.

Mr. PYATT. As you know, I was designated by the Secretary to appear before your committee today. We are here to respond to the concerns discussed in a recent article published by the Boston Globe. This article indicated that Portsmouth Naval Shipyard workers were running an increased risk of cancer due to low levels of radiation. The Navy responded to this article in a statement released on February 23, 1978.

As you all know, the Navy has for years evidenced the deepest concern for the health of shipyard employees working in a radiation environment. Our shipyard radiological control program has been in effect during the entire process of development of nuclear power, and we believe it is one without peer in the world for controlling radiological exposure.

However, in November 1977 some other evidence began to arise in a study of radiation workers at Hanford, Wash., that suggested a possible increase of the risk of cancer due to low-level radiation. While this study is not conclusive, it confirms our conviction that the fullest investigation and the most thorough analysis are required to assess the health effects of low-level radiation.

The Navy has arranged with the Department of Energy for an independent epidemiological study on shipyard workers. The study will be carefully constructed to take into account the many complexities which can influence death rates. This, we believe, is the proper course of action to take, and we are embarked in that direction.

Separately, Mr. Chairman, you and Senator McIntyre have called for such a study to also be performed by the Center for Disease Control under the Department of Health, Education, and Welfare. Secretary Claytor has agreed to cooperate with CDC, and we will be sure that those investigators get the same information that any independent investigator may get.

This offer was confirmed on February 24, 1978, in a letter from Secretary Claytor to Secretary Califano. Since there was some confusion regarding the Navy's position, I have attached a copy of this memorandum for the record, and also a forwarding letter to Senator McIntyre [see p. 1269].

Secretary Claytor feels strongly that we should proceed with the work, that the Navy owes the responsibility to all of its employees to be sure that they work in a safe and healthful place, and we hope to investigate this.

Mr. Chairman, with me is Admiral Rickover and other witnesses who had career-long exposure in planning and development of the Navy's nuclear program, and I would like to turn to them, now.

[The attachments referred to follow:]

DEPARTMENT OF THE NAVY
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20350

February 24, 1978

The Honorable Joseph A. Califano
Secretary of Health, Education and Welfare
200 Independence Avenue, S.W.
Washington, D.C. 20201

Dear Mr. Secretary:

I am in receipt of a copy of a letter addressed to you by Senator Thomas J. McIntyre, dated February 21, 1978, which discusses a study to be accomplished at Portsmouth Naval Shipyard by the Center for Disease Control.

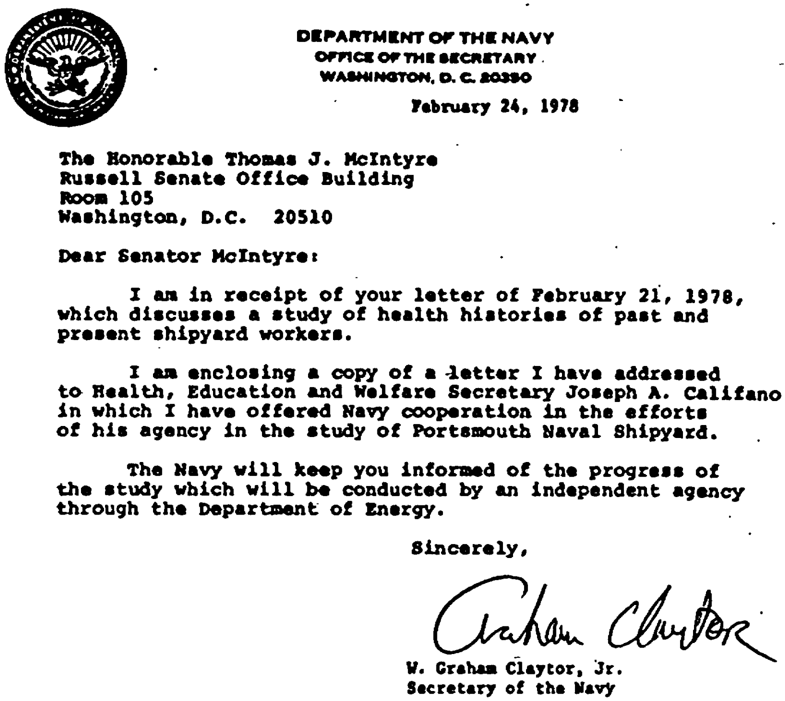
The Navy has, since December 1977, been negotiating with the Department of Energy to have initiated a study by a competent and independent agency of records of Portsmouth Naval Shipyard workers. I anticipate that these arrangements will be finalized shortly.

The Navy will cooperate with CDC by providing to them the same records at Portsmouth as are provided to the independent agency selected. I would suggest that your efforts in this regard await commencement of activities at Portsmouth by that agency in interests of avoiding duplication or confusion. I would further request that you provide me with the name of an individual who can serve as the contact point with the selected agency.

Sincerely,

W. Graham Claytor

W. Graham Claytor, Jr.
Secretary of the Navy



DEPARTMENT OF THE NAVY
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20350

February 24, 1978

The Honorable Thomas J. McIntyre
Russell Senate Office Building
Room 105
Washington, D.C. 20510

Dear Senator McIntyre:

I am in receipt of your letter of February 21, 1978, which discusses a study of health histories of past and present shipyard workers.

I am enclosing a copy of a letter I have addressed to Health, Education and Welfare Secretary Joseph A. Califano, in which I have offered Navy cooperation in the efforts of his agency in the study of Portsmouth Naval Shipyard.

The Navy will keep you informed of the progress of the study which will be conducted by an independent agency through the Department of Energy.

Sincerely,

Graham Claytor

W. Graham Claytor, Jr.
Secretary of the Navy

STATEMENT OF ADMIRAL H. G. RICKOVER, USN

Mr. ROGERS. Certainly. Admiral Rickover?

Admiral RICKOVER. Thank you, Mr. Chairman. I am pleased to appear before this committee to discuss the matter of the health effects of radiation. This has been a subject I have been concerned about ever since I was assigned to Oak Ridge in 1946 to study nuclear power.

I was determined to so design atomic powered naval ships that the crews would be adequately safeguarded. Among other things I was concerned about radiation and about mercury poisoning. For mercury, the problem was relatively simple; I prohibited its use except for medical thermometers. I had some experience with mercury, one of the public utilities that built a powerplant in New Jersey that operated with mercury as a coolant, they finally gave up. I was quite familiar. I also knew that even if you got small amounts of mercury into the submarine, they might give off vapors for months or years. So, I absolutely prohibited it.

There were two other things I was concerned about, the purity of the air, the amount of water and temperature. As far as purity of the air, I think we have greater purity of air in our nuclear submarines than you are breathing right now. As far as water is concerned, we have an unlimited quantity of water, we make enough water to take care of the turbines and of all the men—it is absolutely unlimited.

Then, as far as temperature, we maintain a constant temperature and humidity which is the ideal, always the ideal one under which people should live.

I just point that out, that this business of health is not a new concern of mine.

Radiation was another matter. Little was known about it except the deaths from radiation of workers, some years previously, in a watch factory. They had moistened with their lips the brushes used to paint radium on hands and numbers on the faces of the watches so the time would be visible in the dark. The ingestion of radium resulted in the deaths of some of these workers.

While I was at Oak Ridge, I had discussions with Dr. Herman J. Muller, the Nobel Prize geneticist. We were both concerned about exposure to radiation. I spent hours talking with him. I also visited him at his University of Indiana laboratory where he was conducting studies on irradiated fruit flies. It was clear to me then that if our nuclear ships were to be viable, there would have to be assurance that workers and crews would not be subjected to excessive radiation.

To emphasize this point, I designed the shielding for our naval reactor plants to be many times more stringent than was required by the standards then in effect. Even though these standards have been reduced considerably since then, the design of the shielding in the late 1940's of even the first ship, the *Nautilus,* was so conservative that today it is still more than adequate for what is needed to meet the present considerably lower levels permitted. I realized then that in time, as more became known of the effects of radiation, the permissible limits would be reduced.

I might add another thing. I sent people out in the Atlantic and the Pacific long before the *Nautilus* was operating to check radiation levels in the ocean and under the seas. We assembled all kinds of data, and I would like to say, if there is one part of this program that has concerned me about all, it is radiation. I see many newcomers to the field that feel exactly as I did when I was a junior in high school and all of a sudden I read about socialism. I thought, what a wonderful system that was and I wondered why did not everybody adopt it. I think many people who are now considering radiation think that they have discovered some vast new idea that no one has ever thought about. That is the impression I get from some of the people who get newly involved in radiation, they think nothing has been done about it.

I probably have had more experience with the practical effects of radiation than anyone in this country, and possibly anyone in the world.

My approach to radiation shielding design was not popular in some circles. For example, in 1957, the then Chief of the Bureau of Ships—my boss—wanted me to reduce the amount of shielding in our submarines because this added too much weight to the ship. Likewise, in 1965, a House committee investigated the cost of Navy shielding to determine if my conservative approach cost too much. In each case I held to my determination to keep radiation levels as low as I could reasonably get.

It may be of interest to you to know what happened when the *Nautilus* went into drydock at the Portsmouth Naval Shipyard for the first time in 1959. That was the first time we ever repaired a nuclear ship in a naval shipyard. There are sensitive instruments in a shipyard that measure the amount of radioactivity present in areas adjacent to the reactor plant. These instruments alarm when radioactivity levels reach a point above what is considered normal when the nuclear reactor is operating. As the ship moved into the drydock, with its reactor shut down, these instruments alarmed. We then discovered that these instruments had been set off by the naturally occurring radioactivity in the granite blocks of the drydock. This exemplifies the low levels of radioactivity being considered.

I can give you another example that has happened frequently. When a bomb, an atomic bomb explodes somewhere in the world, let us say in Siberia or anywhere else, in 2 or 3 days the fallout comes over the shipyards such as at Electric Boats and at Portsmouth, and we can measure the radiation there. In fact, at Electric Boats there is a commercial nuclear powerplant located nearby and when they start up the plant sometimes the alarms at Electric Boats sounds off. When we go below in the ship you cannot even measure it.

I point this out to illustrate the concern I have had in this matter since the beginning of the nuclear propulsion program. That concern has never diminished. However, let me emphasize that I am an engineer—not a medical doctor. I do not have the education, training, or background to be able to determine what the long-term medical effects of low-level radiation might be. However, I am a doctor 11 times, and you could call me "doctor," but these are honorary degrees. So, you could address me, Mr. Chairman, as "doctor" and you would not be technically wrong. Nor am I in a position to say what levels of radiation should be permitted, such determinations properly belong to those in the medical profession who possess the appropriate expertise.

In the naval program it is my job to design the ship's powerplants, and to establish and enforce procedures to insure that the established limits are met. These limits apply not only to the radiation an individual worker or crewmember may receive, but also the amount of radioactivity permitted to enter the surrounding environment through the air or the water.

In this latter case, for many years I have regularly issued an annual report which is made public and distributed worldwide. This report gives the total amount from all sources of radioactive discharges from our nuclear Navy. This included 120 nuclear ships; 13 submarine tenders; 2 submarine bases, and all 9 shipyards involved in nuclear work. I have here the report for 1977, which I would like to provide to your committee.

[The report referred to "Environmental Monitoring and Disposal of Radioactive Wastes From U.S. Naval Nuclear-Powered Ships and Their Support Facilities" may be found in the subcommittee files.]

In 1977, as has been the case for the past several years, we discharged less than two-thousandths of a curie into all waters of the world within 12 miles of land. There are other figures in this report which you will find significant. The significance of two-thousandths of a curie is that the radiation to which people are potentially exposed from that amount is equivalent to about six or seven chest X-rays, and that is all the radioactivity that has been discharged from the entire nuclear program, ships, the shore stations, and the tenders.

With regard to the amount of exposure to radioactivity we permit workers and crewmembers to receive, let me say that it has been and continues to be my policy to be as conservative as possible in the design and in the procedures—both on board ship and in the shipyards. I have already discussed one aspect of radiation, the shield design. I not only personally approve every shield design feature of our ships—I also approve any change made to the shield. Over the years I have personally approved large numbers of shielding specifications and blueprints. I do this because I know how important this aspect is to the viability of these ships and to the health of their crews.

In the beginning, there were no procedures for performing nuclear powerplant work in ships. For this reason, I established groups in my own headquarters organization to develop these procedures and the equipment required. I established similar groups in our nuclear laboratories and in all the shipyards performing nuclear work. These groups consist of knowledgeable, trained, and qualified people. Others also had to be found and trained to monitor and enforce the requirements, including radiological matters.

In addition, I have a personal representative at each shipyard; he reports directly to me two or three times a week and with several letters each week, which I personally read. His job is continually to monitor the reactor plant work going on in each shipyard. Among his assistants is a trained individual whose sole function is to monitor the shipyard's radioactive work. And as I mentioned, in addition to telephone calls I receive and read detailed reports of events, including a specific report from a man in charge of radiological work.

Further, every 2 years I send a team of persons from my headquarters staff to audit each shipyard for a week in all aspects of reactor plant work, including radioactive work. I attend the last day of the audit and discuss with the shipyard what we have found, and what additional actions must be taken. Separate audits of radiological performance at the shipyards are conducted at least yearly in each shipyard.

It is on the basis of these considerations that I authorize shipyards to perform radioactive work relating to naval nuclear propulsion plants. Several years ago I withdrew a shipyard's authorization to perform nuclear work because I was not satisfied with its performance, and the shipyard had to stop doing nuclear work until they corrected their condition.

Since the beginning of the Navy's nuclear propulsion program, I have sought out qualified experts in other agencies to conduct independent reviews of significant aspects of the program. For example, the Atomic Energy Commission's regulatory staff, which is now the Nuclear Regulatory Commission, conducts detailed reviews of all naval reactor safety features. The Atomic Energy Commission has also reviewed my radiological safety procedures.

Commencing in the 1950's, the U.S. Public Health Service has, at my request, made independent reviews of Navy radiological environmental controls and has conducted independent surveys. When this part of the Public Health Service was incorporated into the Environmental Protection Agency in 1970, these independent reviews continued as before. The most recent review was conducted by the Environmental Protection Agency in July 1977 at the Portsmouth Naval Shipyard. The Navy has also strongly encouraged each affected State to conduct its own independent surveys. For example, radiation health representatives from the States of New Hampshire and Maine participated in the July 1977 review of environmental radiological control at the Portsmouth Naval Shipyard. I point out specifically Portsmouth because this is the yard that has been chosen as a guinea pig, accusing the Navy of not having been safe in radiation.

The man in my organization whom I hold responsible for this work, Mr. Murray Miles, is here today. He has worked with me for over 20 years. I have known him now for 50 years, and the reason for this is, I held him in my arms shortly after he was born. Here he is.

Mr. MILES. It was only 46 years.

Admiral RICKOVER. Forty-six, I am sorry. I stand corrected, he says it is only 46.

This is typical of seniority of people of my organization. I have long practiced and stressed the need and importance of continuity of management. Mr. Miles has been doing this type of work since he joined me after graduating from college.

An important aspect of ships is their cost; however, Members of Congress well know I have never placed cost above doing what I believe to be technically correct or safe. When I approve a design or procedure, the uppermost consideration is that of reliability and safety. I use my cost-saving energies on the elimination of useless functions, people, and organizations, and by attempting to enhance productivity.

What I have described has resulted in a record which I believe can stand close scrutiny. In the nuclear Navy we have had no reactor accidents which caused people to be injured, or which had a radiological effect on the environment. In this statement I do not include the area which is of concern to this committee—the long-term effects of low-level radiation. As I have stated previously, I am not an expert in this field. Therefore I must rely on scientific and medical experts to make this determination. I take action to enforce the limits promulgated. If it is not possible to reach these limits, it will be up to Congress to decide whether we are to continue using nuclear power for ships or for other purposes. This includes radiation, not only from nuclear powerplants, but also from medical and dental practices, industrial radiography and other uses.

I believe that the field of radiation effects has been one where insufficient effort has been expended. This effort involves many separate groups, all attempting to tackle bits and pieces of the problem. You can go back and find that this subject has been studied, reviewed, and argued for the past 30 years or more. Numbers of so-called eminent scientists have written reports after "exhaustive" studies and have come to conclusions on both sides of the fence.

We have now lived with manmade radiation for over 30 years, and there is sufficient data available to make a reasonable judgment as to what our national policy should be. An analysis on a nationwide scale is long overdue. It will be an enormous undertaking, far outstripping the isolated case of Portsmouth, or even encompassing all the shipyards. I am not the one to say just who should make such a study. It will take a number of years to complete and will require highly skilled people, regardless of statements that have recently been made that it can be done in a couple of months.

Such a study will also require the cooperation of many elements of the population, including the medical profession. It also should be done without the specter of its becoming the basis for future claims against the Government. Few people in the United States have not received some exposure to manmade radiation during their lifetime.

If such a study is done for the purpose of establishing a massive claims program, then we might as well say beforehand that the Government will distribute so many billions of dollars to all U.S. citizens, and be done with it. This issue—to arrive at a level of radiation whose risk is commensurate with the gain—should be resolved first. Otherwise the study will not be conducted properly or achieve its purpose.

The study should include all sources of manmade radiation. From the first, studies of radiation received by individuals for medical purposes have been separated from other sources. I think you are going to be surprised when you find out how much people get in chest X-rays. I believe I, myself, during my lifetime have had more than 100 chest X-rays. I am still here, though, If limits of individual exposure are to be set, then total exposure must be recognized—not just that due to occupational factors.

By the way, I have a rule that the only person in the entire nuclear program who can enter a radiation space without a badge is any four-star admiral over 77 years of age.

That is the only one that is authorized. I thought you would be interested to know that I still have not suffered any ill effects. Also, it is not possible for me to put in a claim against the Government because I have no proof.

A result of this, study should lead to a system of keeping track of a person's total exposure recorded in a national data bank. This has been suggested in the past and rejected.

If we are to live with radiation, and I believe we can, the issue of radiation and its effect on man must be resolved. The public will then have assurance that it is not being subjected to harmful effects, and there will not continue to be unsettling news items.

If you succeed in accomplishing this, Mr. Chairman, your hearings will have done a great service to our people; they will have removed one fear from our highly complex industrial world, and set a landmark of what can be accomplished in a democracy by a responsible congressional committee.

I thank you for the privilege of presenting my views to the elected representatives of our people.

Mr. ROGERS. Thank you very much, Admiral Rickover, for a very helpful statement.

There is a call to the floor for a vote for House Members. I think House Members will have to go, but I think Senator Hathaway, if he desires, will begin his questions. We would continue the hearings, then.

Senator HATHAWAY. Thank you, Mr. Chairman, I will have to leave myself for a vote at 2:30.

Admiral, thank you very much for an excellent statement. Presumbly late in the 1950's, when standards were established, that was done on the basis of some scientific study; is that correct? Standards of exposure.

Admiral RICKOVER. I cannot answer that. There were people such as Dr. K. Z. Morgan, I believe you know who he is, that helped establish standards. We took the standards that were nationally established, Federal standards and we not only complied with them, but we always did better.

Senator HATHAWAY. Your testimony is that you do not know the scientific basis for them, but you complied with all the standards.

Admiral RICKOVER. No, sir, I do not. That is not within my specific competence. Just like with anything else, there are Federal standards for food, for all sorts of things, and we comply with those. I just adopted those standards. I have been occasionally asked, why have you not started major studies? But what if I drink water and do not like it, is it my responsibilities to start major studies on the purity of drinking water? I cannot do that, I have a big job to do myself, and I have to depend on other recognized and authorized agencies to set the standards. I cannot do that myself. That question has been asked.

Senator HATHAWAY. And were these standards changed from time to time over the years?

Admiral RICKOVER. Sure, they have. Remember, I mentioned earlier that I designed the shielding. I designed it, actually, to be about 10 times as good as it was currently required because I knew that the standards were going to be lowered. The standards that I set up at that time are completely valid today. So, my tendency has been always, in radiation, to be completely conservative. In fact, that is true in my whole outlook in engineering, and that is why our ships work so well because I have always taken a very conservative approach in anything of this sort.

Senator HATHAWAY. So, the level of radiation exposure has gone down over the years?

Admiral RICKOVER. Yes; per man it has. My attitude is very simple: Would I be willing to have my son serve on that submarine? That is my attitude, that is the attitude I take on everything I do.

Senator HATHAWAY. Now, the workers wear film badges; is that correct?

Admiral RICKOVER. Yes, sir, they do.

Senator HATHAWAY. Naturally, if you want to defer to any of the other members of the panel to answer the questions, I would be happy to have you do so.

Admiral RICKOVER. If I cannot, if you need a question answered in detail, if I cannot answer it, I will defer to one of the others.

Senator HATHAWAY. Now, are these badges the same today as they were back in 1958 and 1959?

Admiral **Rickover**. No, sir, they are much improved.

Senator **Hathaway**. What have they done to them, do you know?

Admiral **Rickover**. First, they are now such that they can be read very quickly, where it used to take several hours to get an answer. You can read them almost instantaneously now. That is the main fact.

Senator **Hathaway**. To the best of your knowledge, do they accurately measure radiation exposure?

Admiral **Rickover**. Yes, sir, they do. They are checked. They are scientifically designed, and they do to the best of our knowledge. We use the same, radiation exposure instruments as are used in other parts of radiation work. We do not design these instruments ourselves; that is not my job. May I amplify that?

Film badges were used until October 1974. Since October 1974 the shipyard has been using thermoluminescent dosimeters they are called TLD's—to measure radiation exposure. A film badge contains one or more photographic emulsions of various degrees of sensitivity to beta particles, gamma rays, X-rays, or to the internal neutrons. Film packets are placed in holders which are especially designed to differentiate between these types of radiation.

After exposure to radiation the film packets were developed under controlled procedures and the density which is proportional to the amount of radiation received is measured. Film badges detect these various types of radiation energies.

The new dosimeter consists of two chips of calciumfluoride with added manganese, sealed in a glass envelope. The glass envelope is contained in a shielded case especially designed for energy response. These chips are in contact with a metallic heater strip. It is characteristic of these chips to emit light when heated, provided they have been exposed to gamma radiation. The intensity of the light is directly proportional to the amount of radiation exposure. An electronic device measures the intensity of the light and converts this to a digital readout in units of radiation dose. The TLD measures gamma and X-ray radiation. A different type of TLD measures neutron radiation. Due to the limited range of beta radiation, the controls over and the type of work performed during the overhaul of nuclear submarines, personnel are not exposed to beta radiation. However, exposure of personnel to beta radiation is monitored by performing radiation surveys of work areas and controlled by the use of anticontamination clothing. Alpha radiation is not found in a nuclear power overhaul work performed at Portsmouth, though we do cover it.

Here is a document I have, it is headed, "Occupation Radiation Exposure Receipt by Personnel in the Naval Nuclear Program." I think you will be interested in this, so I will read it. I am going from 1969 on.

"The total personnel monitored was 57,000, and the total man rem was 14,000." It goes on. When we get to 1977, we have reduced the number to 36,000, and the total man rem is only 8,000. We have actually considerably reduced the radiation per individual in all that time.

I am giving copies of this for the record for each Member.

[The following chart was received for the record:]

OCCUPATIONAL RADIATION EXPOSURES RECEIVED BY PERSONNEL

IN THE NAVAL NUCLEAR PROPULSION PROGRAM (1)

1969 - 1977

Year	Number of Persons Monitored Who Received Exposures (2) In The Following Ranges of REM for the Year						Total Personnel Monitored	Total Man-rem (3)
	0-1	1-2	2-3	3-4	4-5	>5		
1969	52815	2266	1158	675	379	0	57293	13951
1970	47525	2578	1460	753	492	0	52808	15063
1971	46304	2369	1151	672	242	0	50738	13909
1972	50702	2270	1026	152	6	0	54156	10269
1973	43947	1979	707	218	7	0	46858	9270
1974	30822	1759	811	312	50	0	33754	9351
1975	30471	1445	626	82	42	0	32666	7520
1976	30852	1639	689	39	0	0	33219	7951
1977	34136	1623	681	61	3	0	36504	8019

(1) Data obtained from summaries rather than directly from original medical records. However, it is expected that the large effort to compile comparable data from original medical records would show differences no greater than five percent.

Included are Navy and civilian personnel from ships and their supporting tenders, bases, and shipyards, who are monitored for radiation exoposure associated with Naval Nuclear propulsion plants. Exposures from NRC or State licensed radiation sources and exposures at DOE prototypes and laboratories have been excluded as far as practicable.

(2) No personnel exceeded 3 REM per quarter year during the period 1969-1977.

(3) Total Man-Rem was determined by adding actual exposures for each individual during the year.

Senator HATHAWAY. Fine, thank you.

But of course, I suppose it is possible for workers to swap badges, if they wanted to.

Admiral RICKOVER. I have never heard of a case like that. Of course, it is possible.

Senator HATHAWAY. In Portsmouth.

Captain McDONOUGH. It is of course possible, but I have never heard it being done, and I see no advantage in it.

Senator HATHAWAY. Well, maybe to get overtime pay.

Captain McDONOUGH. No; it has nothing to do with their pay.

Admiral RICKOVER. No, sir. Radiation workers do not get any pay different from anyone else.

Senator HATHAWAY. Now, the badge itself, though, would not measure the inhalation of dust, or what might seep in through a cut, as testified to this morning by Dr. Najarian.

Admiral RICKOVER. The nature of our work is such that we have very little if any radioactivity radiation in the air. The work mostly deals with solid material. Now, cuts are another matter. If a worker has a cut, we do not let him work.

If there is any question of ingestion, we measure that by use of whole-body counter. But we normally do not have that problem because we are dealing primarily with solids. That is not a problem with us.

Senator HATHAWAY. No dust can be inhaled, as Dr. Najarian testified this morning?

Admiral RICKOVER. As I previously indicated, the nature of our work produces little if any radioactive dust.

Senator HATHAWAY. You cannot inhale those.

Admiral RICKOVER. There is practically nothing to inhale.

Senator HATHAWAY. So, you are saying the badge would determine just what exposure the worker was exposed to.

Admiral RICKOVER. If he works around piping or so on—I will give you a better example. Monitoring of air samples is performed in areas where radiation work is carried on, and where operations are conducted which might cause airborne radioactivity. Work areas are monitored by continuous air samples, or by periodic air samples taken at least every 4 hours to assure airborne radioactivity is not present. Shipyard supervisory personnel review the results of air samples. Nuclear workers are informed immediately when airborne radioactivity in their area is measured and is above limits. Corrective actions are then taken—but there is practically none.

It is not the kind of work, if you were working in a factory where you could get stuff in the air, we do not have that. It is inherently working with solids, but we do monitor for it.

Senator HATHAWAY. You could get it in your body through a cut, and that would not be measured.

Admiral RICKOVER. Yes; touching something that is radioactive. But we do not permit people with cuts to work. They are not permitted to work in radiation areas.

Senator HATHAWAY. I see. So, the badge does measure everything, the best you know.

Admiral RICKOVER. Yes, sir.

Senator HATHAWAY. Now, are records kept of all the workers, as to how much they receive?

Admiral RICKOVER. Yes, sir; we keep records every day.

Senator HATHAWAY. How long have they been kept?

Admiral RICKOVER. They have been kept from the very beginning.

Senator HATHAWAY. Right from the beginning.

Admiral RICKOVER. Yes, sir.

Senator HATHAWAY. So, what would the record show of an individual employee?

Admiral RICKOVER. I will give you some figures to show what the total records show.

The permissible radiation allowance by the Federal standards is 5 rem a year, 5.

Senator HATHAWAY. Right.

Admiral RICKOVER. The admissible quarterly allowance is 3 rem per quarter. But we nearly always do not go up more than five total. The least limit is five a year, but the maximum, take Portsmouth Navy Yard, over a period of many years the maximum total exposure of any individual is 40 rem for all the years that is for one person. We have no other cases of anythng as high as that, that is just one. But the average radiation that a man receives, the maximum, is about 2.5 rem for the whole time. Outside of one or two unusual cases, that is the maximum we get. It is far below the national standards.

Senator HATHAWAY. Yes, but does the record show how much he gets on a daily basis, exposure?

Admiral RICKOVER. Yes, sir.

Senator HATHAWAY. For every day of the week, every hour of the day that he worked there?

Admiral RICKOVER. He cannot work in radiation unless he wears his badge, and it is recorded every day.

Senator HATHAWAY. And that has been the practice since 1959?

Admiral RICKOVER. Yes, sir, that has always been the practice.

Senator HATHAWAY. If there have been any accidents where a large exposure occurred, then that would be recorded on that man's record?

Admiral RICKOVER. We would know, yes, sir. I think neither you nor many other people are aware—I have tried to say in a broad sense the great care we have taken—of the actual great care we have taken. Of course, some things go wrong, but there is no area of this work which is given as much attention. There are many newcomers who think that all of a sudden they have discovered that there is radiation. Many people have been working on this for over a quarter of a century, perhaps almost before they were born. They do not understand that because they are not familiar with it.

Senator HATHAWAY. Now, is any followup study conducted routinely, after a worker stops working?

Admiral RICKOVER. Yes, sir. A man gets a medical examination before he starts work. If he gets exposed to as much as 0.5 rem, he then gets a medical examination every 3 years; and every worker gets an examination when he leaves employment. We have the complete records for all those.

Senator **Hathaway**. Yes, but is there any followup after, to see what happens to that individual?

Admiral **Rickover**. I do not think there is.

Senator **Hathaway**. Do you know before you hire someone how much exposure he may have had? Do you have any background information?

Admiral **Rickover**. Not necessarily, we cannot tell that because, naturally, if a man wants to work in a radiation place, he would not tend to say that he had been exposed previously, and we may not have any records. But we do keep records of the amount he receives in our program.

Senator **Hathaway**. I see.

Admiral **Rickover**. I think you will find in your State that there is less disease adjacent to your State—I do not know if you claim Portsmouth Navy Yard.

Senator **Hathaway**. Yes; we claim it.

Admiral **Rickover**. You claim it.

Senator **Hathaway**. It is in Kittery, Maine.

Admiral **Rickover**. Watch out that the Indians do not find out.

Senator **Hathaway**. Listen, after these hearings we may be glad to give it to them.

Admiral **Rickover**. But actually you will find that the general health of the workers in radiation is better than the health of the general public.

Senator **Hathaway**. Well, they may not live as long, according to Dr. Najarian's study. He said the incidence of leukemia, for example, was 450 percent higher.

Admiral **Rickover**. I will make my point on that. The Boston Globe—and that is not your State, I would not think of taking on a paper in your State because you are probably going to run for office again——

Senator **Hathaway**. I have been taking them on, so, go ahead.

Admiral **Rickover**. The allegations about radiation, they made their own survey, and they were doing it for the good of the public, which of course is the policy of all the newspapers in this country. And yet, when they were asked by the shipyard commander to give the facts so they could do something about it, they would not turn them over. They would not turn over those facts so that we could check.

Senator **Hathaway**. At what stage was that, now? I do not believe the doctor's study was completed until just recently. I asked the doctor if we could hold hearings on January 16 on this matter, and he said that would be for too early, he would not be ready until March.

Admiral **Rickover**. I am not talking about the doctor, I am talking about the Boston Globe.

Senator **Hathaway**. Well, the doctor did the study for the Boston Globe. I do not know if they had anybody else working besides the doctor.

Admiral **Rickover**. Yes, but the Boston Globe published statements that they had all these records. Naturally we got quite concerned that perhaps they had information that we did not have, and we are sure that all newspapers having the major objective of the welfare of the public, would furnish the data so we could check.

They would not do it, and their excuse was that they wanted the data that the Navy had in return. But we are bound by law, by the Privacy Act, not to hand out information about individuals. We cannot do that. So, here they are permitting people possibly to be dying of cancer and they will not tell us. Now, there is your public spirit.

In other words, the freedom of the press belongs, as you know, to the man who owns the press. I should think after hearing this—and I am sure there is a representative of the Boston Globe present, the first thing he would do—and I hope this is printed in the newspaper—is let us know what he found so we can try to do something about it. But they want a scoop. I hope they print that in their sheet.

Senator HATHAWAY. Well, maybe we can get them to testify here today, but I understand that the conclusions they printed in the paper were based on Dr. Najarian's study.

Admiral RICKOVER. Well, if that is the case, then Dr. Najarian has information we ought to have, if he is interested in the welfare of our people.

Senator HATHAWAY. He was here this morning, I do not know whether he could stay this afternoon, or not.

Well, is it an accurate quote—I do not know if you said it, but some source, a Navy spokesman said that the surveys indicate no problems such as those described in the Boston Globe. Would you say that is true?

Admiral RICKOVER. I do not believe anyone in the Navy used those words "no problem." I doubt that.

Senator HATHAWAY. So, you did not say that.

Admiral RICKOVER. I certainly did not. Radiation is a problem, and people have been irradiated. The question is whether they have been irradiated to an extent which harms them. I do not think any responsible person would say there is no problem.

Senator HATHAWAY. Are you saying that the conclusions drawn by Dr. Najarian, or those printed in the Boston Globe, whoever did them, are not correct?

Admiral RICKOVER. I do not know, I have never seen the studies. We cannot tell.

Senator HATHAWAY. We have copies here.

Admiral RICKOVER. Well, if you will give us a copy, we would like to look at it.

Senator HATHAWAY. There were newspaper in general circulation and probably you, or your subordinates have seen them. Someone in the Navy Department has seen those reports.

Admiral RICKOVER. Senator, the fact that they say this does not mean much, unless we can see the facts, the figures they have which support what they state. They will not furnish them to us, we asked for them.

Senator HATHAWAY. Has the Navy been negotiating with the Department of Energy since December to initiate a study by some independent agency?

Admiral RICKOVER. Yes, sir.

Senator HATHAWAY. Can you tell us how that is coming along?

Admiral RICKOVER. I think I understand from Mr. Miles that the people are going to be here later this afternoon. Now, we approached them—not as a result of the Boston Globe or the doctor supplying the information—we did it because of the report about Hanford. The primary reason for the study of naval shipyards was the new indication of increased cancer risk from the Department of Energy study; that was at Hanford.

The first questions from the Boston Globe were received after the December 13 meeting, which organized the Department of Energy study. However, Dr. Najarian's public hearing in Dover, N.H., on December 7, 1977, was considered in making the decision to explore, conduct a mortality study. But the initial impetus came from the Hanford report.

Senator HATHAWAY. Let met ask one question before turning it back to the chairman.

Has the Navy or any other Federal agency that you know of conducted a study on the long-range effects of constant low-level radiation?

Admiral RICKOVER. I cannot answer that question. I think people have for many years, as I mentioned in my prepared statement, done bits and pieces of the thing. I do not think there has been any proper scale investigation. You remember I last said, if we are to live with radiation, the issue of radiation and its effect on man must be resolved. The public will then have assurance that it is not being subjected to harmful effects, and there will not continue to be unsettling news items. If you succeed in accomplishing this, this committee, your hearings will have done a great service to our people; they will have removed one fear from our highly complex industrial work.

Now, the British have started such a study. But I repeat, contrary to what some witnesses may be telling you, or other advisers, it is not going to be done in 2 months. It will take many years to do it. But it had better be started right now.

Senator HATHAWAY. How many years?

Admiral RICKOVER. I would guess it probably would be as much as 8 years or so. That is a pure guess. You may get some results, some reasonable results earlier, but it will take years to get really meaningful results. If this committee succeeds in that, you will really succeed in getting a handle on this thing. All you have at these hearings now, is the Boston Globe crying out about the horrible things that are being done; and you are having the Navy and others come to you and tell you, "We have done everything we can." Well, maybe we have not done enough, maybe we have to find out more. I suggest this myself, I am not saying there is no potential problem—I do not know. But to the best of our knowledge, ability, and to the best scientific evidence that we have, we do not see a problem. Maybe there is one and we do not see it.

Now, there is another thing you should be aware of. On February 12 of last month Dr. Phillip Handler, the head of the National Science Foundation, delivered an address. The most important part of his address was about scientists running around and making statements that they cannot verify. This comes from the top scientific organization, the Association for the Advancement of Science, they had their meeting here. He takes off at these people. Just because they are called doctor does not mean that they have the expertise or the knowledge. As I mentioned before, I have 11 doctor's degrees, and I would hesitate to become an expert in this field.

So, you have to be very careful. It is easy for anyone with the title of "doctor," regardless of his lack of experience, to go make these statements, and stir up all the people. Fortunately, in the Portsmouth Navy Yard the workers have taken a very reasonable attitude. According to the information I have, they do not seem too concerned. They know that we are looking out for them. Maybe we are not doing enough, I cannot answer that. That is what you would find out if we had a real investigation conducted. I think that is about the only conclusive thing that can come out of this meeting.

Senator HATHAWAY. Well, I think the reason for the workers' lack of concern is, this is something that will happen sometime in the future. It is like telling someone today to quit smoking cigarettes, they do not necessarily feel that they have to because of something that is going to happen later on in their lifetime. I have had a chance to talk with the workers the other day.

Admiral RICKOVER. They are taking this attitude because they feel they are going to get cancer later on?

Senator HATHAWAY. Well, I guess that is why. If they were feeling pain now, they certainly would be concerned. I cannot see how we can wait 8 years to make any changes.

Admiral RICKOVER. Senator, would you take that attitude for yourself, if you heard this news? Would you?

That is a good question because if you say "yes," then you are impugning the intelligence of your voters.

Senator HATHAWAY. No; I do not think so. I think that is probably common among all human beings, that something that is going to happen 10, 20 years from now that might happen, they might die a little bit earlier, they are not going to be as concerned as if you told them they are going to be hurt tomorrow.

Admiral RICKOVER. Well, that would be tantamount to accusing me, but I have been in this game for 30 years now, and certainly in a period of 30 years you could look 20 years ahead. I just want to point that out.

Senator HATHAWAY. Right. But I think if you took a survey of everybody here in this room, people in general, that they would not be as concerned about something that may happen to them 20 or 30 years from now, as they would be if something was going to happen to them tomorrow morning.

Admiral RICKOVER. Well, you know that somebody dies every 1½ minutes and from smoking, and you can tell the smokers. But here we have direct evidence every day of what we have given to those people. We have pretty good knowledge what it takes over a lifetime to do any real harm. That is the difference. You cannot keep track of how many cigarettes the man smokes, there is no record; nor does he know what is going on inside of him. But we do know what is going on inside these people, we at least have records that go back to 1959.

Senator HATHAWAY. Well, you would not say to await the outcome of 8 years of study before we take any action, would you?

Admiral RICKOVER. What action would you take? If I knew what action to take, I would take it. We operate below the levels that are set by the Federal Government. I do not know what action to take.

Senator HATHAWAY. Set the level even lower.

Admiral RICKOVER. We do use a lower level.

Senator HATHAWAY. Well, we could put it even lower than what we are using right now, just to be on the safe side.

Admiral RICKOVER. Well, look, one man has been mentioned from Portsmouth as having been subjected to radiation. We estimate if he had lived in Denver—he has been quoted as a possible cancer victim—if he had lived in Denver, he would have gotten 10 times as much radiation on account of the higher altitude. Now, therefore, to follow your line of reasoning, we would have to move everybody from Denver down to the sea level, perhaps to Maine.

Senator HATHAWAY. I am just saying because of the figures that Dr. Najarian has, and his discovery, to be on the safe side we could lower the level until we do get the outcome of these studies that we are going to ask for at the conclusion of these hearings.

Admiral RICKOVER. I would put that word "discovery" in quotation marks.

Senator HATHAWAY. Well, to be on the safe side, I would say that until we disprove it, there is probably considerable validity to it.

Admiral RICKOVER. What do we do if next week somebody else named Smith comes out with a similar statement as you got here today, what do we do then?

Senator HATHAWAY. Similar to what, Dr. Najarian's statement?

Admiral RICKOVER. Yes. I mean anyone—and this is why I mentioned what Handler talked about scientists sounding off about things they do not know very much about. I am sure Dr. Najarian never knew before he started this that so much thought, and work, and consideration had been given to this radiation problem. I am sure he was not familiar with that at all, he thought he was discovering a new world.

Senator HATHAWAY. Well, he is not here to answer for himself, but I doubt that he thought he was discovering a new world.

Admiral RICKOVER. Well, I am using that in a metaphorical sense.

Senator HATHAWAY. Well, I have used up a little bit more than my 5 minutes. Thank you.

Mr. ROGERS. Dr. Carter?

Mr. CARTER. Thank you, Mr. Chairman.

I certainly am pleased to see the admiral, whom I have known for many years, and in whom I have great faith.

Admiral RICKOVER. Thank you, sir.

Mr. CARTER. I congratulate him for his efforts to protect the men in our submarines. I think he has done a tremendous job.

Admiral RICKOVER. You have a nephew in this program, and he has lived over 20 years in the nuclear Navy and has become an admiral. So, that shows you, that is the way to get advanced. Subject yourself to this naval radiation, and you get to be an admiral.

He is doing a good job, by the way.

Mr. CARTER. Thank you.

Admiral RICKOVER. That is a good reflection on you and your family, too, you know. An indirect way of saying that.

Mr. CARTER. Yes, sir. It is good to have you here, and if there is anything you want to expound on, you have my 5 minutes.

Admiral RICKOVER. Thank you, sir.

Mr. ROGERS. Mr. Markey—oh, I am sorry.

Admiral RICKOVER. Dr. Carter, you are a doctor.

Mr. CARTER. Four times, not eleven.

Admiral RICKOVER. You are four times?

Mr. CARTER. Yes, sir.

Admiral RICKOVER. But 3 of them are fake, like I have 11.

I would rather you would ask me questions because I think in a Socratic dialog we can get something out of this.

Mr. CARTER. All right, sir, I will do that.

Admiral, when did the Navy first become aware of the possibility that the cancer death rate among nuclear workers at the Portsmouth Shipyard might be higher than expected?

Admiral RICKOVER. I do not believe we have ever become aware of that.

Mr. CARTER. Then you do not credit Dr. Najarian's report as being truthful; is that correct?

Admiral RICKOVER. Dr. Najarian, he or the Boston Globe, whom he worked with, has never been willing to supply us with the information that he has. I do not believe you were in here, you were at a rollcall. The point I made, it is quite reprehensible to me on the part of a public newspaper, if they have information which is detrimental to the health of people, they hold it out for a scoop, and they are supposed to serve the public. I remarked on that before you came in.

I merely repeated something you well know, that the freedom of the press belongs to the man who owns one.

Mr. CARTER. Absolutely.

Admiral RICKOVER. You have found that out, too?

Mr. CARTER. Oh, yes, sir.

Admiral RICKOVER. So have I. I have been quoted in the press for doing things I have never done. What do you do, do you take off? If you take off, it gets worse. You cannot win in taking on the press. I hope the members of the press who are here understand that. It is a losing game ever to get in an argument with the press. They have the final word. They are the source of all knowledge and wisdom—they see all, hear all, and know all.

Mr. CARTER. I want to agree with you, go right on.

Admiral RICKOVER. You do, or do not agree with me?

Mr. CARTER. I do agree with you.

Admiral RICKOVER. Because you are running for office.

Mr. CARTER. I certainly do agree with you, but to recall Thomas Jefferson's opinion on this, "were it left to me to decide whether we should have a government without newspapers, or newspapers without a government, I should not hesitate to prefer the latter."

Admiral RICKOVER. We do not know, as far as any facts are concerned we do not know of there being any greater incidence rate of cancer or leukemia among workers subjected to radiation. But, as I mentioned before, we should learn. Were you here when I mentioned what the primary purpose of this hearing should be? To establish a disinterested group of people to study this whole thing and come out once and for all with a legitimate and scientifically conducted study that will show what we really have. We do not know.

Mr. CARTER. I would agree with that. I am afraid we do not know many of the things about radiation.

Admiral RICKOVER. You know, if you look back at the history of the Earth, at one time, in my opinion, it was impossible to have any other than insect life because the radiation levels were so high; and it probably took about 2 billion years before the radiation levels decreased. You know the law that in about six times the half-life it decreases before you could have animals of any kind. There is plenty of radiation still left. There is one place in India where the radiation is about as much as around an atomic reactor because there was enough natural concentration of thorium to cause that.

Mr. CARTER. Yes, sir.

Admiral RICKOVER. So, there is plenty of it left yet. Mankind has had to, to some extent, become used to it.

Mr. CARTER. Yes, sir. Are you familiar with the linear hypothesis of radiation effects?

Admiral RICKOVER. Well, that is a fancy word. It looks to me like you have been studying up some big words to pull on me——

Mr. CARTER. No; really, I have not. We have been going over that in our hearings.

Admiral RICKOVER. I do not know these big words because I am too busy doing real work. You must have a lot of spare time.

Mr. CARTER. Is there a direct relationship between the amount of radiation and the incidence of leukemia and cancer? As radiation exposure increases, does cancer increase?

Admiral RICKOVER. We have no evidence that radiation exposure received by individuals working on naval nuclear propulsion plants have caused increased rates of cancer. In the first place, there is no assurance that outside of massive doses of radiation you are going to get cancer. We really do not know enough about this. But it is so easy to spread that word "cancer" around. The amount of radiation that we give is pretty small.

Mr. CARTER. Now, you mentioned radium dial watches. If we go back to Madame Curie, actually one of her associates was burned by radium. Then her husband got a little of it, and he was burned himself.

Admiral RICKOVER. I can explain that.

Mr. CARTER. All right, but he wanted to prove the effect of radium.

Admiral RICKOVER. Madame Curie did not know, there was no real knowledge at that time of the effects of radiation. It was not known. It was only quite a bit later than that. Even about 10 or 15 years later, there were radium wristwatch workers.

Mr. CARTER. We did not know then.

Admiral RICKOVER. We did not know then, either. So, this is a new phenomenon which probably started mostly with the Manhattan district. Now, I remember I came back to Washington a couple of times when I was in Oak Ridge in 1946 and 1947, and I went to the Sears & Roebuck store, took my son there to get a pair of shoes. They had an instrument there where all the kids were putting their feet in so, and they could see the bones in their feet. This was in 1946 and 1947.

I complained to the manager of that store, and he thought I was a nut—he probably sized me up pretty well.

Mr. CARTER. No; you were right, of course.

Admiral RICKOVER. Well, everyone is a nut until the others agree with him.

Mr. CARTER. Well, you were certainly right. I feel that you contained the radiation exposure to the operating crews on your nuclear subs, and I think the record sustains that.

Admiral RICKOVER. We do.

Mr. CARTER. The record supports that. However, I do feel that radiation from atomic explosions can cause adverse health effects. But in my opinion, you have done a masterful job on our submarines.

Admiral RICKOVER. Well, I am not talking about bombing, somebody being in the vicinity of bomb explosions, those are very high doses. Now, there are not even any good records from Hiroshima, you know, where people were exposed for an instant to massive doses of radiation. It is a very elusive thing. Those who are quite familiar with this whole field must be very careful in making public announcements which scare the people.

Mr. CARTER. I see.

Admiral RICKOVER. This was, again, the reason for my recommendation that we start this study to alleviate the fear that so many people have because cancer, you know, is a horrible word and has many connotations. We have to be very careful when we throw this word around.

Mr. CARTER. I know that quite well. I certainly want to complement you on what you have said. I could go on quite a while, but I have used up my 5 minutes.

Thank you for coming here to testify. I want to go on record as being in favor of giving you a fifth star. I have introduced resolutions in the past for you——

Admiral RICKOVER. Do not mention that to the Pentagon.

Mr. CARTER. It does not matter. We did not ask them before, and we will not ask them the next time.

Admiral RICKOVER. Thank you, sir.

Mr. ROGERS. Mr. Markey?

Mr. MARKEY. Thank you, Mr. Chairman.

Admiral, it is a pleasure to have you here today.

Admiral RICKOVER. Thank you, sir.

Mr. MARKEY. You mentioned that the Globe should have turned over the data that you requested. But was not the Globe and Dr. Najarian forced to go through 100,000 death certificates, piece by piece, death certificate by death certificate because the Navy would not cooperate with their study? That the Navy even cited the privacy provisions of the Freedom of Information Act to deny the release of the names of the deceased workers?

Can you explain to me why the privacy of a deceased person, when the public health and safety is at stake, could be invoked and should be invoked to prevent a respected doctor and a respected national journal from having access?

Admiral **Rickover**. Mr. Markey, we do not know how that Globe study was conducted, we know nothing about it. We have never been told. That is the first point.

The second point is, there is a Privacy Act which ties us up in what we can do. We went to legal counsel and they said that we have an obligation to protect the rights of the families of the dead people and their heirs. The lawyers told us that, and we acted on accordance with the legal advice we got.

Mr. **Markey**. What protection would be given to a deceased person, his rights of privacy; what rights of privacy does that person have?

Admiral **Rickover**. Well, he is an heir. I do not know, I am no expert. This was not a decision that was made by me, it was made by the Navy Department. I had nothing to do with that decision.

Mr. **Markey**. You had nothing to do with it?

Admiral **Rickover**. I had absolutely nothing to do with it.

Mr. **Markey**. Is there anyone else on this panel who had anything to do with it?

Captain. **McDonough**. I forwarded the request to my headquarters in Washington according to instructions, and legal counsel recommended against it to protect the families. We had had several phone calls from relatives showing their concern.

Mr. **Markey**. In weighing the public interest as opposed to the rights of those deceased people, just so we can get some kind of handle on the potential dangers of low-level radiation, do you not agree that perhaps it is in the public interest that we make these kinds of records accessible to medical personnel?

Admiral **Rickover**. Mr. Markey, medical personnel who will not release it to the public is something else. Mr. Markey, you heard my major recommendation, and I believe the most important thing that could come out of this committee hearing is to start such a study by proper people, and do it thoroughly.

Mr. **Markey**. Do you think that the CDC is the proper people?

Admiral **Rickover**. The arrangements were made between Mr. Califano and the Secretary of the Navy, I had nothing to do with it. I found out a week after it was done, I had nothing to do with it. However, the Department of Energy is getting a group of people, outsiders, with no idea one way or the other what should be done. I think that is a fine idea.

Now, the Navy has also told the CDC that whatever information we give the independent group they also can get. So, there is no harm done there.

Mr. **Markey**. Dr. Rose of the CDC says that he can make preliminary findings in 2 to 3 months by tracking the history of 1,000 workers from the early 1960's. Does the Navy dispute that the findings can be done this quickly and still be valid?

Admiral **Rickover**. Well, from my experience I would say that is so; you could not.

Mr. **Markey**. You could not accept the validity?

Admiral **Rickover**. I cannot argue. If CDC, an official Government agency does this—has he ever been denied this, did he say he was denied this information?

Mr. Markey. No; what we are saying is, if he made this study and get it back here in 2 or 3 months, would you abide by the recommendations that were made by the medical personnel?

Admiral Rickover. No, sir, because one of the big problems in that is the records. You will find as you get into this whole game that medical records are pretty horrible for many things, including cause of death. I do not believe that you can, the statistics that are being used are not very good. This is why I say that there should be a thorough study.

Mr. Markey. The Navy acknowledges in its statement to the Globe that its health program includes keeping detailed medical records, including radiation exposure, on each and every worker.

Admiral Rickover. That is not a death certificate, though. When people leave, when they die, you will find the records—as we have found—are not very good.

Mr. Markey. The Navy records are not very good, is that what you are saying?

Admiral Rickover. Any kind of medical records. I think the Navy records are probably far better than they are elsewhere because when a person in the military service dies, there is the issue of Government benefits. To get back to Dr. Rose, I doubt that the Navy would not supply him the information he wants. I doubt they would not give it to a Government person who had been assigned the responsibility?

Can you answer that question? You are from the Bureau of Medicine and Surgery.

Captain Rivera. The records will be released; yes, sir.

Mr. Markey. What we were wondering is the statement, which says that the Navy will cooperate with CDC by providing to them the same records at Portsmouth as are provided to the independent agency selected. Does that mean you will give CDC any records which they request if, in their determination, it would make it possible for them to make an accurate determination of the potential danger of low-level radiation?

Admiral Rickover. He says the Navy decided to do that before this hearing today.

Mr. Miles. Yes; that is a matter of record.

Mr. Markey. I just wanted to make sure.

Mr. Miles. We are interested in getting the studies.

Mr. Markey. Fine.

Admiral Rickover. We are not quite as bad as you think we are, Mr. Markey.

Mr. Markey. I hope not.

Admiral Rickover. I know not.

Mr. Markey. Now, I am also trying now to get a hold of who has responsibility within the Navy to make these kinds of decisions. According to a list of titles attributed to you, they include the responsibility for the radiological control measures established by the Navy to govern radiation exposure by personnel engaged in naval nuclear propulsion work, responsibility for implementing but not establishing Federal radiation exposure limits; and the day-to-day responsibility to enforce work standards. Admiral Rickover established work standards, approves general procedures to be followed and enforces inspection and oversight activities on a programwide basis.

Do you accept that characterization of your duties?

Admiral RICKOVER. Yes, sir, I do.

Mr. MARKEY. Fine.

Admiral RICKOVER. I set up those rules and I am not going to shirk what I set up. Of course I do, I feel personally responsible for anything that happens radiationwise on any person connected with this program, whether it is a naval person or whether it is a worker in the yard.

Mr. MARKEY. Thank you, sir.

Is it attributed to you:

> "People are easily pressured into permitting so-called progress to alter their lives without attempting to control it as if they had to submit meekly to whatever is technically feasible. There is a need for laws requiring that before a particular technology may be used, reliable results must have been made to prove that it will be useful and safe.

A 1972 study made by the National Academy of Sciences, Committee on the Biological Effects of Ionizing Radiation, the so-called BEIR Commission. It said that the risk of low-level radiation was just not known despite the careful study of all published data on radiation effects. This was reported in 1972.

What I am wondering is, in light of a study done of this nature, why the Navy, being the only people having access to this kind of massive documentation did not begin your own study so that we could decide whether and how much exposure to low-level radiation we should give to our workers. Why was a study not conducted in 1972?

Admiral RICKOVER. The Navy does not have access to this information. The Navy does not have the information when a person leaves the Navy, or when a worker quits, and that is when people die, when they get older. The people who leave the navy are generally young men.

We do know that this committee has asked about the incidence of deaths caused by radiation on the first crew of the *Nautilus*. Do you have these figures? Let me give you some figures here.

This is the status of the first crew of the *Nautilus*. The total crew members were 96; alive and well today, 94—and that started operating in 1955, that is over 20 years. Dead, 2—total deaths, which is much less than I think you would find normally. One lymphosarcoma—I would have to defer to somebody else—that was a steward who had no radiation exposure. One artherosclerotic heart disease; rating: Torpedo man; exposure 0.8 of one rem during the whole time.

So, what does that prove?

Mr. MARKEY. Well, let me give you some statistics and you can ask me what these prove, all right?

The Boston Globe with Dr. Najarian surveyed the deaths of 146 people who had been working in the Portsmouth Naval Shipyard; 56 of the 146 people who have died, 38.1 percent died from cancer—38.1 percent. The national average is 18 percent.

The leukemia death rate for the shipyard employees who worked in exposed areas is 450 percent higher than the general population.

Between the ages of 60 and 69, 60 percent of those workers exposed to radiation died of cancer.

What do those statistics tell you?

Admiral RICKOVER. Well, Mr. Markey, why don't you get this gentleman to turn this data over to us, and we will check it?

Mr. MARKEY. Well, more than check. I want to know why the Navy affirmatively——

Admiral RICKOVER. Well, you are taking that statement at face value, we do not agree with that. We would like to know how he got his figures. Now, when you ask me about the *Nautilus*, I give you accurate figures, those guys are alive.

Mr. MARKEY. We are talking about civilian employees here, and we are talking about a study which in many ways was spawned by a report in 1972, by an independent study, the BEIR Commission. I am wondering why the Navy did not respond to it, why they did not affirmatively go out and find out whether or not the levels of radiation which may be accepted internationally, which may be accepted nationally, but may not be safe to our workers?

Admiral RICKOVER. Because we had no evidence.

Mr. MARKEY. The BEIR report.

Admiral RICKOVER. From our own people we had no evidence, there was no reason. We are obeying national standards. If you want to get after this, I suggest you get after this——

Mr. MARKEY. All you accept is the minimal standards in your life? I have always known that you were a man who tried to go beyond that and tried to excel.

Now here is a case where there was a warning flag thrown up 5 years ago, and you only still accepted the national level, rather than something which would satisfy you.

Admiral RICKOVER. I do not take that as a warning light.

Mr. MARKEY. What would you want?

Admiral RICKOVER. Well, let us get someone K. Z. Morgan who is now saying we ought to have reduced standards—was one of the group that set these standards. Now he is saying something else. I do not know how to handle a thing like that.

Now, I have some statistics which I read off when you were not in here, you were on the House floor. I will give you some figures on the occupational radiation exposure received by personnel in this program. I will give you some figures here. I am going from the year 1969 to 1977. I will take first the total number of personnel monitored, and the total man rem in that year.

In 1969 it was 57,000, and there were 14,000 man rem. In 1970, there were 53,000 and 15,000 man rem. In 1971, there were 51,000 and 14,000 rem. In 1972 there were 54,000 and 10,000—notice how that number is going down. In 1973, there were 47,000 and 9,000 rem. In 1974, 34,000 and 9,000 rem. In 1975, 33,000, and 7,500 rem. In 1976, 33,000, 7,900 rem, and in 1977 there were 36,000 and 8,000 rem.

I think we have done pretty well going down. We do not have evidence. We have no evidence. I do not know whether you were in here at the time, there was one man who was a patient of this doctor. He was supposed to have gotten a certain amount of radiation. If he had lived in Denver, he would have gotten 10 times as much, just from living there.

Now, what do we do about that?

Mr. MARKEY. We make rules, we do not make them for the exceptions. The problem here is that when you were talking earlier about the shields which you installed years ago, you said you always erred on the side of safety.

Admiral RICKOVER. Yes, sir.

Mr. MARKEY. And here we have the case where there was some indication years ago that there was a reason for you again to institute special care in view of your position in charge of safety for these nuclear facilities you should have been able to institute an analysis of some of these records, which were easily accessible—not to the Boston Globe and not to Dr. Najarian, but to you, and you, and you, the people here who have that responsibility.

Admiral RICKOVER. You think then—I made an extreme case—if I did not like the drinking water in Alexandria, I should start a big study? I am only working 14 hours a day now. I do not have time to do that, there are other people getting paid. Why didn't you think about it at the time and start something?

Mr. MARKEY. Well, unfortunately the time that you started in nuclear power in 1946 I was being born.

So, I admit I am coming to the issue late; all right?

Admiral RICKOVER. Well, you are the rising generation, I know, I defer to you. But we have felt this responsibility, but there are many things that should be done, that are not done, and only Jesus Christ can do all of them; I can't.

Mr. MARKEY. You can't, but you have the U. S. Navy to give you a hand.

Admiral RICKOVER. We have the Department of Energy, we have the Public Health Service, we have HEW—why not go to them and ask them? There were people charged with this.

Mr. MARKEY. You are responsible, you accepted the responsibility.

Admiral RICKOVER. Well, yes; I am responsible.

Mr. MARKEY. You agreed with the description of your responsibility.

Admiral RICKOVER. Well, you also, now that you are old enough, so are you responsible.

Mr. MARKEY. That is why I am here.

Admiral RICKOVER. Well, you can get this started. I am sorry, I fell down on my job, and I admit it, and I apologize. We end it on that basis.

Mr. MARKEY. Thank you. No more questions.

Mr. ROGERS. Mr. Walgren?

Mr. WALGREN. Admiral Rickover, you are what is known in the law as a difficult witness.

Admiral RICKOVER. Me a difficult witness? I tell the truth.

Mr. WALGREN. Well, from my point of view you are a difficult witness because I am younger and you have a lot of rank to pull on me. I think I would just like to point out that upon close reading your statement seems to me to be extremely supportive of Dr. Najarian. I really feel that if you go through the colluquy that you had with the committee—if someone does—they will see the kernels of support for what Dr. Najarian basically said.

I do not quite know where the difficulty is. I do not feel that this is youth attacking age, or newcomers saying people who went before did wrong. But we are trying to push for a sensitivity that I think you have had, but that other people have not. I noticed you said you never let anybody go into a radiation area without a badge who was not 77 years old.

Admiral RICKOVER. Correct.

Mr. WALGREN. Other people in the service made it a practice to let that happen all the time.

Admiral RICKOVER. No, sir.

Mr. WALGREN. Well, the testimony before this committee is that it happened as late as 1956 in the hundreds of thousands in those bomb explosions.

Admiral RICKOVER. Now, look, I have had nothing to do with bomb explosions, I cannot answer to that. In fact, I was present at two of them.

Mr. WALGREN. I understand. But what bothers me, is that you have a record of taking this issue extremely seriously. The other witnesses that have made light of the problem, as you have around the edges, have not taken it seriously at all. In fact, when we tried to find out, after prodding, what efforts they were making to develop records that could be examined, we found that the Army had one man spending one-quarter of his time to track down these records until this committee literally had to dynamite them into action.

I really hope that you do not leave the hearing thinking that the younger members are attacking your record, I think you confirmed in all your statements that: You know of no long-term health study; that you believe it is essential that it be conducted; that the description that you have given to the committee of the care that you have brought to this area can stand close scrutiny—and it can—except that in your own honest words you do not include in that area the area that is of concern to the committee, that is, the long-term health effects of low-level radiation.

I think you are being very open about it. I think what has happened here is that the service has offered up the person who has taken the greatest care, and who has done a wonderful job in another area, and attempted by that to indicate that there are no problems in this particular area.

When I read your testimony I see your recognition of the problems, and I really want to compliment you for that.

Admiral RICKOVER. May I comment now?

Mr. WALGREN. Yes.

Admiral RICKOVER. In the first place, as you know, I am a great advocate of proper education for all our people. One statement I have frequently made is that the primary duty of a legislator is the education of its youth—that comes from Aristotle—I said that all the time. Under no circumstances must you think, I am telling you this, that I look down on young people because if anything is to happen in this country it has got to come from young people because the old ones are already fouled up, and they are not going to do any better. So, I want to make that very clear. I have many young people working in my organization, I like them very much, and I see the only hope for my own organization is to hire and train good young people with some promise. I do that all the time.

For instance, last week, in addition to all my other work, I interviewed 200 people coming from colleges to pick out the best ones to enter the nuclear propulsion program. I have interviewed every person who is an officer in the entire nuclear program. I interviewed 13,000 or 14,000 people. I do it all the time because the most important thing I can do is to select and train the young people. That is where the entire future is, and I put a great deal of my work.

I want to tell you very humbly, if you have any idea that I am looking down on young people, I absolutely do not, it is completely contrary to my nature. That is one point.

The other point you raise is, or you implied, why did not I get into this radiation for bombs.

Mr. **Markey**. No; I did not imply that.

Admiral **Rickover**. I am sorry. So, I make this point, if I had known of anything I could have done, it was possible for me to do in this or any other area, I would do it. I do not know all these things either. I do know this, that the statistics are very incompetent, those statistics on deaths in this country, we have already found that out—for various reasons, and I do not know what they are.

Therefore you must have a completely disinterested group who goes into these records, and you will find that is going to be the stumbling block, hospital records, not radiation records. What happened later on? Why did they die? You will find the statistics are pretty horrible and it is very difficult to determine.

That is why this group must be composed of very outstanding people, and we are trying to do that.

I know that you are very much in earnest and I am just as earnest with you. I would welcome you as a friend—and I am not talking in any legal sense. I do not want you to think that I take off at anyone because they are young in Congress.

Mr. **Walgren**. I want to go back to just one point you made when you said that Dr. Morgan had set up these standards, that you—and no one would expect more—can only follow and use them as some kind of a guide as to what is proper and reasonable at the time. You said he set up the standards, and now he is saying something else, and you do not know how to handle that.

Well, you handled that in your testimony, did you not, when you said that you understood and really had foresight enough to anticipate that the standards would be changing, and therefore you really insisted on the safety designs and tried to overdesign the machinery.

Admiral **Rickover**. Yes; I think right now—and the standards have been changed several times, always downward during this period. I think even if they are changed now, we can still live with them. But there may come a certain point when we cannot, and that is what I meant, at that point it would be up to Congress to decide, if there are really truly disadvantages, whether we should have a nuclear Navy or have atomic power.

Mr. **Walgren**. The way I see it, the question here is not whether or not we should have a nuclear Navy. The safety of this Nation is basically based on what you have been at the head of developing. I am concerned the sensitivity is how we handle nuclear power—for example, the suggestion of being able to wear suits in certain instances where we now don't wear suits. You would probably agree, would you not, that our sensitivities in this area are developing, our understanding of the effects of occupational low-level exposures are being revised downward; and that we have to be sure that we are doing everything to understand what the truth of the matter is.

Admiral RICKOVER. Mr. Walgren, you are right. But the point I am trying to make, we must be careful that we do not seize some apparent statistics and make too much of them. We should find out what those statistics really mean, and that is going to take a long time. I was asked how many years I thought it would take, and I think it is going to take quite a number of years to get down to the nub of the thing. The biggest stumbling block is going to be the validity of death certificates and a lot of things of that nature, that are really going to determine the issue.

Mr. WALGREN. I would just like to close with the thought that there is a basic problem that we have because, as you say, from the military and from the nuclear industry standpoint now we are saying essentially that we do not see a problem.

Admiral RICKOVER. No, no; I have never said that. I have been accused of that. I believe I was asked that question by one of the members here. I have never said that there is no problem. As far as I know today, radiation is not good for you. The Chief of the Bureau of Ships urged me to cut down shielding. You know what he said? He said, "Maybe we are going to find out that radiation is good for you." I do not believe that it ever can. I did not mention that in here, but now that you raise the point. As far as I know, no radiation is good for anyone.

Mr. WALGREN. Well, we did say earlier, and you did say earlier, that to the best of our present knowledge—and I am not attacking on this point—to the best of our knowledge at present we do not see a problem. Now, that is a perfectly valid statement, and I accept that as true. The problem is that when you couple that with what we have also accepted, and that is that there are no studies at the present time of the long-term damage, what we have is great handwriting on the wall that we would be well advised to pursue it in the form of a study.

Our difficulty is, I think, and some of our frustration is that the other witnesses that we have had, have been part and parcel of resisting studies. I am not classifying you in this instance, I am saying that the Army that have come before us, the DOE that have come before us—and there is every reason to look at that testimony from an objective standpoint—that they are being dragged kicking and screaming into this process.

My only point is that we admit that we do not have any studies. And this is the question, do we all agree that there are great danger signs that any prudent person would follow, and initiate an extremely disciplined look into this problem?

Admiral RICKOVER. May I answer?

Mr. WALGREN. Yes.

Admiral RICKOVER. I appreciate very much your forthright and very intelligent commentary. I do not agree with the last part of your statement that there is a cloud there. I do not agree with that, I do not know whether there is, or not. I would like to find out.

I believe that what we are doing today is perfectly safe, I believe that. However, I cannot prove it or substantiate it. I can substantiate to the extent of the records we have of the people that have died in this program over the last 20 years or more, a quarter of a century since it has been in existence—I cannot talk about the bomb. You are talking about high-level radiation, and we are really concerned here with low-level radiation, which is the most insidious kind. I do not know. Whenever I get into a situation that I do not know—enough years have not gone by yet to find out—I would like to find out in order to assuage public feelings about what is going on.

That is the basis for my recommendation. Now, I very much appreciate this discourse with you, I am very sincere, it is a very intelligent discourse. I understand what concerns you. I would like to assure you as much as I can on what I know—I can only talk about my program now. I would tell you, you talked about being a lawyer. If I were you lawyer and this were a law case I would tell you that you have no real concern, but I do not know. Now, that is as fair a statement as I can make. If I knew, I would do something about it.

Mr. WALGREN. Thank you, Mr. Chairman.

Mr. ROGERS. Admiral, we appreciate your being here, I think you have tried to be forthright. I think we have all agreed we need to do a study to find out about low-level radiation. I think we are all agreed on that.

Admiral RICKOVER. Mr. Chairman, but do not let people sell you the idea that you are going to get a quick and dirty study out of this that has any meaning.

Mr. ROGERS. Well, I think we will have to get a scientific, sound study. I agree, it has to be proper.

Now, let me ask you this—and maybe I should address this to Mr. Pyatt for the shipyards—who sets the radiation standards for workers in the naval shipyards and on the nuclear ships?

Admiral RICKOVER. I set the standards.

Mr. ROGERS. For the workers as well as the Navy?

Admiral RICKOVER. Yes, sir.

Mr. ROGERS. Now, you changed the standards, I think, did you not, in 1966?

Admiral RICKOVER. I think I have an answer to that. There was a question, why was it dropped from 12 rem to 5 rem as the amount of radiation exposure allowable for workers? Was this recommendation of any specific person or agency? The reply was, when the International Commission on Radiological Protection issued Publication No. 9, it retained the 3 rem per quarter as its limit. However, it emphasized that whenever practical, personnel should not exceed 5 rem. My program applied this recommendation by instituting this lower level as a rigorous limit. Portsmouth Naval Shipyard complied with this instruction. Whenever there was any evidence, we complied with it.

I admit, to talking to Mr. Walgren, I admit, I should have done more; but I can only do so much.

Mr. ROGERS. We all should do more, Admiral, I do not think anyone is saying you should do more than anyone else. All we are trying to do is get at the problem now.

As I understand it, you did change the standards in 1966.

Admiral RICKOVER. We lowered them to what the international standards were. Now, in the beginning of December 1977, the Navy received a copy of the study of the effects of low-level radiation at Hanford. This study indicated a possible increase of cancer. While the study was discounted by some reviewers, the study indicated a potentially higher cancer rate due to low-level radiation, than was expected.

Accordingly, the Navy began working with the Department of Energy to attempt to set up a study of shipyard workers. That is a partial answer. That has nothing to do with the genesis of this hearing.

An initial meeting on December 13 led to a formal request for a study on December 30. As the preliminary work was done in January, the Department of Energy consultants from Oak Ridge Associated Universities, and the Hanford Environmental Health Foundation reviewed a sample radiation health program at the Charleston Navy Shipyard on February 14, 1978. The consultants concluded that a study was feasible, and the Department of Energy agreed to the study on the 16th of February. That partly answers what you said, Mr. Walgren.

Mr. ROGERS. Now, let me get to my question, Admiral.

Admiral RICKOVER. Yes, sir.

Mr. ROGERS. I believe you changed the standards in 1966.

Admiral RICKOVER. Yes, sir.

Mr. ROGERS. Now, it is my recollection that it was in 1957 or 1958 at the latest when the recommended standards were suggested. I wondered why we did not make a change from the recommended standards.

Admiral RICKOVER. May I check that, sir?

Mr. ROGERS. Yes. I just want to finish by statement.

Admiral RICKOVER. Yes, sir.

Mr. ROGERS. Why the recommended standards that AEC adopted—at least by 1958—to reduce, were not then adopted by the Navy until 1966. Is there any reason for that?

Admiral RICKOVER. I am trying to find what the facts were.

Mr. ROGERS. Certainly.

Admiral RICKOVER. Could you tell me where you got that information? If I cannot do it now, I would like to supply it.

Mr. ROGERS. From our hearings here when we had the AEC, Department of Energy. Perhaps we have a representative here from the Department of Energy. Do we, in the audience?

Admiral RICKOVER. Mr. Miles says he can answer that question.

Mr. ROGERS. Yes, Mr. Miles?

Mr. MILES. The standards in about 1959 were changed from 15 rem a year to an average of 5 rem per year of age over 18. They put in effect a 3 rem per quarter limit. Those were instituted immediately in the Navy's reactor program in 1959.

The point is that in 1965 we were still using 5 rem per year; we were still using 3 rem per quarter. We were using 5 rem per year average, which allowed at 3 rem per quarter for you to get as much as 12 rem in 1 year.

Mr. ROGERS. Not if it is a 5 rem standard for the year.

Mr. MILES. Five rem per year average of the years of age over 18. The formula is 5 times age minus 18. You could get 3 rem per quarter, 12 a year until you caught up.

That was the way the world, the United States operated after the change in 1959.

Mr. ROGERS. You mean, it was your understanding that——

Mr. MILES. Twelve rem a year was the limit.

Mr. ROGERS [continuing]. That change was 12 rem?

Mr. MILES. Yes, sir.

Mr. ROGERS. Rather than 5?

Mr. MILES. Twelve rem a year is the limit today, still.

Mr. ROGERS. Was not a change made and recommended by AEC in 1958 or 1959? It went down to 5 per year, 3 per quarter, did it not?

Mr. MILES. The point was, it has been 15 per year up to that point.

Mr. ROGERS. Exactly.

Mr. MILES. And what they changed it to was a formula of five times your age minus 18 years. So, if you were 25 years old and that was the first year you had service, you were allowed 35 rem. You could catch up at the rate of 3 rem per quarter until you caught up to that formula. That is today's rule.

Mr. ROGERS. That you can get 12 rem per year?

Mr. MILES. Yes, sir.

Mr. ROGERS. The 5 rem is not the controlling figure for the year?

Mr. MILES. That is right.

Mr. ROGERS. Well, now, that is contrary to what AEC told us.

Mr. MILES. Five rem is the average.

Mr. ROGERS. Well, I am talking about to the individual.

Mr. MILES. That is right, the individual has to come out averaging 5 rem.

Mr. ROGERS. Suppose I get 3 rem the first quarter; I get 2 more rem the second, that is 5. I cannot get 5 rem that year.

Mr. MILES. You sure can.

Mr. ROGERS. Pardon?

Mr. MILES. You sure can, by today's standards.

Mr. ROGERS. Now, that is not what they told us.

Mr. MILES. The point the admiral is making is that in his program in 1965 we changed it to 5 rem as a rigorous limit.

Mr. ROGERS. Oh, you are talking about not the normal standard, but a special exemption.

Mr. MILES. Special only if you report the man's radiation exposure for his past history. But almost every radiation worker in the United States has that done, so, that special exception is not very special.

Mr. ROGERS. Who has all that done, whole body; all workers have it done, did you say?

Mr. MILES. Most employers record the radiation exposure history, that is the only requirement in the Nuclear Regulatory Commission rules.

Mr. ROGERS. The whole body, you are telling us?

Mr. MILES. That you have a record of what was done in the past. If you choose not to make a record of the past radiation exposure, then you are required to keep to 1.25 rem per quarter. At that rate you cannot exceed 5 rem a year.

Mr. ROGERS. But what you are permitting is 12 rem a year, now.

Mr. MILES. What the country is permitting is 12 rem a year. Our program changed to 5 rem per year rigorously in 1965, in spite of the fact that the country allows more than that, still.

Mr. ROGERS. But you did not change that until 1965. Why was the change not made until 1965?

Mr. MILES. Because in 1965 the International Commission on Radiological Protection came out with a new report, No. 9, which said they liked 5 rem a year. They did not think people ought to get much more than that, except in highly unusual situations. It was pretty fine print in the book. We took that pretty fine print and decided we had better live by it as a formal rule; and we have.

Mr. ROGERS. Did you consult AEC?

Mr. MILES. Yes, sir.

Mr. ROGERS. And they did not think you should change until 1965?

Mr. MILES. It was not put out until 1965, sir.

Mr. ROGERS. I am talking about the original change recommended by AEC in 1957-58.

Mr. MILES. That was put into effect immediately.

Mr. ROGERS. You did change, then.

Mr. MILES. To 5 rem per year average, the formula.

Mr. ROGERS. As of what time? I thought you told me it was in 1966 you did it.

Mr. MILES. There were two changes. One change in about 1959, that changed from 15 rem a year to 3 rem per quarter, and a formula which is five times the person's age minus 18.

Mr. CARTER. Mr. Chairman?

Mr. ROGERS. Yes, Dr. Carter.

Mr. CARTER. If you will permit me, sir, I believe you are referring to a NRC regulation of January 1, 1977. It is an exception, which permits exposure of five times the result of a person's age minus 18 rem's.

Mr. MILES. If you want the NRC's statistics on this for a number of people in lightwater reactor programs that NRC regulates, that have over 5 rem, there were almost 300 people in 1976, and 250 people in 1975 who exceeded 5 rem. We have had zero in the last 10 years.

Mr. ROGERS. Now, what do you have to do to permit over 5 rem, is it a special order; is it a special recognition? How is that determined?

Mr. MILES. In our program, there is a sentence in Admiral Rickover's rules on radiological control to the fleet and to the shipyards that says, "This five times age minus 18 formula can be invoked to exceed 5 rem a year on approval by Admiral Rickover." Nobody has dared to apply for it in those 12 years. Nobody has exceeded it, nobody has bothered to apply; it would not be approved.

Mr. ROGERS. So, you have not permitted anyone over five per year, or are you talking about an average?

Admiral RICKOVER. For the last 10 years.

Mr. ROGERS. What about the accumulation of the 12?

Mr. MILES. Well, you cannot get over 5 a year, so you cannot go to 12. They have not exceeded 3 rem per quarter, and they have not exceeded 5 rem per year in our program in the last decade.

Mr. ROGERS. In other words, you are saying there is no one that has been exposed to 3 rem in one quarter, and then 3 rem at the end of the year.

Mr. MILES. That is correct.

Mr. ROGERS. Three the first quarter, and three at the end.

Mr. MILES. The rules before 1958 talked about——

Mr. ROGERS. I am talking about now.

Mr. MILES. All right. The early rules allowed a rolling year that you have to worry about. When the limits were dropped as low as they were, to 5 rem, they stopped arguing about rolling that on. Yes; you can get 3 rem in the first quarter of the year——

Mr. ROGERS. What about the second?

Mr. MILES. You can get another three in the first quarter of the next year; but it is not a rolling year. You can use it by calendar years.

Mr. ROGERS. Can you, say, in the first quarter of the year get three, and in the second quarter of the year get three?

Mr. MILES. No, sir.

Mr. ROGERS. You would not permit that.

Mr. MILES. That is correct.

Mr. ROGERS. As soon as he reaches five, he would be taken off. What action do you take?

Mr. MILES. Take him off. He has plenty of other work to do. They spend a very small percentage of their time actually doing radiation work. A machinist has a lot else to do besides radioactive work.

Mr. ROGERS. So, you are not allowing anybody in your programs, including the workers—not just the naval personnel—to get over 5 rem, which is the suggested standard.

Mr. MILES. That is correct.

Mr. ROGERS. Now, what were you telling me about the 12 that could be permitted on exception?

Mr. MILES. The country allows 12.

Mr. ROGERS. On the exception.

Mr. MILES. But it is not a very rigorous exception. All you have to do to make that exception is fill in the person's past radiation exposure. Now, we do that for 100 percent of our people anyway.

Mr. ROGERS. Well, I think a positive decision has to be made by the licensee; does it not?

Mr. MILES. Yes, sir. But as you see from the NRC's own statistics, several hundred people exceeded 5 rem last year.

Mr. ROGERS. Yes.

Admiral RICKOVER. We had zero.

Mr. ROGERS. On the over five.

Admrial RICKOVER. For the last 10 years we have not exceeded 5 rems per year.

Mr. ROGERS. All right. Now, have there been any overexposures at Portsmouth? You tell us evidently there have not.

Admiral RICKOVER. Yes; there have been, and I will give you the figures. Prior to 1963, 14 Portsmouth Naval Shipyard workers exceeded the quarterly radiation exposure limit of 3 rem from radiation associated with naval nuclear propulsion plants. The highest one exceeded the limit by four-tenths of 1 rem. No one has exceeded the cumulative lifetime limit. No one has been injured from an accident involving radiation exposure.

Mr. ROGERS. How about at other shipyards?

Admiral RICKOVER. Mr. Miles can give you that information right now.

Mr. ROGERS. All right.

Mr. MILES. The overexposure history of this program is, at all shipyards there are 33, 14 of them were from Portsmouth.

Mr. ROGERS. What period of time does that cover?

Mr. MILES. All before 1968. Nothing has happened since 1968. There were three aboard nuclear-powered ships. So, in the history of the program there have been a total of 36.

Mr. ROGERS. Thirty-six total, and you have had none since 1968.

Mr. MILES. 1967 was the last year.

Mr. ROGERS. 1967. Now, what is the highest total lifetime exposure in rems of any nuclear worker?

Admiral RICKOVER. The average lifetime radiation exposure for personnel at all nine shipyards performing radioactive work associated with naval plants is about 1.5 rem.

Mr. ROGERS. Total lifetime.

Admiral RICKOVER. That is the average lifetime.

Mr. MILES. Total lifetime.

Admiral RICKOVER. Total lifetime. For all these workers who were employed at a shipyard in 1977 and were performing radioactive work, about 12 percent have lifetime exposures of greater than 20 rem, and less than 1 percent have lifetime exposures greater than 30 rem. The highest lifetime exposure of any workers who were employed at a shipyard in 1977 and were performing radioactive work associated with naval nuclear propulsion plants was less than 50 rem. That is the total lifetime. That is an unusual, even that is a very unusual case.

Mr. ROGERS. Now, who has the responsibility of maintaining and following the health records?

Admiral RICKOVER. The responsibility is done by the Navy yards, but they have strict rules which they must follow, such as checking the badges every day, warning the workers, and so on. And, if anything happens, we are immediately notified.

Mr. ROGERS. Captain McDonough, what is the procedure at your shipyard? I believe you command Portsmouth?

Captain MCDONOUGH. Yes, sir. The procedure is that when a man comes to work in the shipyard and is going to work in the nuclear area, he is given a physical examination. He is given a repeat physical exam every 3 years. Also, every day that he works his exposure is recorded. That night it is put into the computer, and the next morning when he comes back, his current annual radiation exposure history is available.

If he approaches our administrative levels—not gets to them but just approaches them—we have an alert system that alerts the supervisor, and we take a look. Is there a mistake? Is he getting more exposure than we had thought? Therefore, when he approaches our administrative exposure limit we take him out of radiation work.

At our administrative level that we set at the shipyard right now, we stay well below the Federal limit of 3 rem per quarter and 5 rem per year. We have an administrative level of 1 rem per quarter and 2 rem per year, so that we do not endanger ourselves by coming even close to Federal limits.

Mr. ROGERS. Is that your judgment to do that? In other words, the local commander can set the standard in his shipyard?

Captain McDONOUGH. I can pull it back, that is, make it lower. Our purpose is to have as low as reasonably achievable an exposure. It also is a way of controlling costs, Mr. Chairman.

Mr. ROGERS. And who are the personnel who actually keep the records?

Captain McDONOUGH. Well, in the shipyard we have a radiological control officer.

Mr. ROGERS. How many are in that office?

Captain McDONOUGH. About 100.

Mr. ROGERS. In your shipyard?

Captain McDONOUGH. 125 in my shipyard. It fluctuates according to the number of ships you have. We keep exposure records in the Radiological Health Division and make sure that the thermoluminescent dosimeter, the TLD that the admiral referred to, is turned in every night, read, put into the data bank, and the next morning it is available. Now, we can look at any person. When the man goes to work it is his responsibility to look at his record, what he has had before because he bears the responsibility to make sure he knows what his exposure is and that he does not go over. He looks at it before he goes into a radiation area, and he has to write it down. He shares the responsibility with me.

Mr. ROGERS. What type of indicator do you use?

Captain McDONOUGH. We use the TLD, thermoluminescent detector.

Admiral RICKOVER. That is the one I described previously.

Captain McDONOUGH. And we also use a little chamber, we call it the pocket dosimeter, where a man can read it right at the time. He is responsible to read it while he is working.

Mr. ROGERS. Have you had any overexposures at Portsmouth?

Captain McDONOUGH. Not in my time.

Mr. ROGERS. You have not. Have any come close to 3 rem?

Captain McDONOUGH. Let me see, not to my knowledge in a quarter. Last year, 1977, when I had some 1,400 workers involved in the program, 67 percent of them, basically 829 of them, were below 0.5 rem for the whole year. Between 0.5 and 1 rem, I had 170 people for the whole year. Between 1 and 2 rem I had 276 for the whole year. Between 2 and 3 for the whole year, I had 52, and I had 1 between 3 and 4. Now, he was not over the Federal limit.

The goal, as I said, is 1 rem per quarter, 2 rem per year, to stay well away from the Federal limit.

Mr. ROGERS. Now, if they have one or two per year, what action do you take? Suppose they reach two, which is your standard.

Captain McDONOUGH. What I can do then because only about 15 percent of my work is nuclear work, I will use him elsewhere in nonradiation work. I have other people to assign to radiation work.

Mr. ROGERS. Have you had any get as much as 2 rem at one time?

Captain McDONOUGH. Not to my knowledge, no.

Mr. ROGERS. There has been no accident to have exposed anyone that high. That is cumulative.

Captain McDONOUGH. Those are cumulative numbers. No.

Mr. ROGERS. None at a high rate at all.

Captain McDONOUGH. No, sir.

Mr. ROGERS. Now, were you contacted at all by the Center for Disease Control regarding the study?

Captain McDONOUGH. No, sir, I have not heard from them concerning this study.

Mr. ROGERS. Mr. Miles, I guess it was you who had been contacted by the Center for Disease Control on the study?

Mr. MILES. Yes, sir.

Admiral RICKOVER. They now, the Center for Disease Control is now formally into this picture. They will get exactly the same information, or additional information if they wish, that we are going to give to this independent study.

Mr. ROGERS. I think this needs to be clear, that any information they need for their study, they will get. Is that correct?

Admiral RICKOVER. That is correct.

Mr. ROGERS. I think that is reassuring to the committee.

Admiral RICKOVER. I would like to, if I may, I would like to say more about radiological control at the navy yard.

Mr. ROGERS. Certainly.

Admiral RICKOVER. Now, the radiological monitoring program includes the design of equipment, worker training, preplanning, working in verbatim compliance with written procedures, monitoring of personnel radiation exposure, use of radiation shielding, and containment of radioactivity during work operations. This is true of all the yards. Shipyard management insures proper control of radioactivity. The radiological control program at the yard commenced 1 year before the first radiation work began at Portsmouth. We started 1 year ahead of time in training. Ever since its inception the program has exercised stricter requirements than those in the Federal regulations.

Here is a brief summary of the radiological control at Portsmouth. All personnel are required to receive training in various aspects of radiation work and in radiological controls prior to being authorized to perform radiation work. The initial training course must be completed in order to become qualified to work in a radiation area. This qualification requires satisfactory completion of a written exam, as well as satisfactory performance during simulated work operations. Every radiation worker must requalify in the same manner every 2 years. In addition, each radiation worker must attend a refresher training course to formally update his knowledge of radiological controls at least every year. This training is performed by full-time instructors in a shipyard radiological control office. Training is also conducted by individual shop instructors in specific job skills for radiation work within each trade. Periodically training bulletins discussing radiological control matters are distributed to be read and discussed with the radiation workers.

Radiological control surveys are taken on a frequent basis by trained and qualified physical science technicians in the radiological monitoring provisions of the radiological control office. These consist of routine surveys of various facilities, as well as surveys of each individual radiological work operation performed.

Surveys are conducted on radiation levels, radioactive contamination levels and airborne radioactivity concentrations. Results of surveys and monitoring are reviewed by supervisory personnel to provide a doublecheck to assure that no abnormal conditions exist.

In addition, many operations are monitored continuously by radiation detectors and air samplers. The instruments used for monitoring and survey operations are checked daily and prior to use, and receive regular calibration and maintenance. These surveys provide a continuous picture of radiological conditions in all areas of the shipyard.

Perhaps the most restrictive regulations in the radiological control program are established in the requirements for the control of radioactive contamination. Any work operation involving potential for spreading radioactive contamination is planned in accordance with strict specifications requiring total containment to assure that no person becomes contaminated.

Mr. ROGERS. If you do not mind, I will get you to put that in the record for us because of our time elements.

Admiral RICKOVER. I merely emphasize that I do not believe that you have in this hearing heard the details of the very strict and expensive controls that we maintain. That is why I can come up here and talk with such great confidence.

[The following information was received for the record:]

The shipyard's controls for radioactive contamination are so strict that the shipyard has sometimes had to take precautions to prevent tracking contamination from "fall-out" and natural sources into nuclear areas, because the contamination control limits used in the nuclear areas were below the levels of natural contamination occurring outside, in the general public areas. A basic requirement of contamination control is the monitoring of all personnel leaving any area where radioactive contamination could possibly occur. Because this monitoring is complex and is to very low levels, routine showers after work are not required. The basic approach is to prevent contamination, not wash it away.

Admiral RICKOVER. Now, I would appreciate if I may change the record to correct anything, and add other information for the record?

Mr. ROGERS. Certainly.

Admiral RICKOVER. Do you wish me now to terminate?

Mr. ROGERS. No; I was just saying for this moment because of our time, and I wanted to get to some other matters.

Admiral RICKOVER. May I have your permission to leave now, unless you have more?

Mr. ROGERS. I may have a question or two more, thank you. We will try to conclude as soon as possible.

As I understand it, there has been no record—well, you keep your health records, I believe you said, for 3 years?

Captain McDONOUGH. These records we keep continuously. We have records on the radiation exposure of every man who has been in the program since the day it started.

Mr. ROGERS. So, you have those available.

Captain McDONOUGH. We have the radiation exposure records, yes, sir.

Mr. ROGERS. And the health records?

Captain McDONOUGH. We keep the health record of the civilian employee as long as he is in our employ. When he departs or retires, it is sent to the records archives in St. Louis, I think it is; after he has departed for a while.

Mr. ROGERS. Admiral, I would like to bring to your attention a case that has been brought to my attention, and I think we need to have it checked, from a Mr. Fred A. Nelson, who is vice president of NOVA University in Fort Lauderdale, Fla. He was the nuclear officer onboard the U.S.S. *Oriskany,* is it? Is that correct?

Admiral RICKOVER. That is a weapons system.

Mr. ROGERS. A weapons system?

Admiral RICKOVER. That has nothing to do with nuclear power.

Mr. ROGERS. It had no nuclear power, no nuclear weapons?

Admiral RICKOVER. It is not a nuclear-powered ship. He was called the nuclear officer, I suppose, in connection with his work in nuclear weapons.

Mr. ROGERS. But it was not nuclear powered?

Admiral RICKOVER. No, sir. The *Oriskany* is not a nuclear-powered ship.

Captain McDONOUGH. It is an aircraft carrier.

Admiral RICKOVER. It is an aircraft carrier, but not nuclear powered.

Mr. ROGERS. Would he have handled plutonium, or enriched uranium?

Admiral RICKOVER. I have no familiarity at all with what goes on on that ship, that is outside of my area of responsibility.

Mr. ROGERS. Whose jurisdiction would that be?

Admiral RICKOVER. It would be the Navy. If you wish to address a question, I can see that it gets to the person.

Mr. ROGERS. I think it would be helpful.

Admiral RICKOVER. I will get it to the proper person.

Mr. ROGERS. Because he wrote that he had handled plutonium and enriched uranium during 1960 and 1961, when he contacted, I believe, Vice Admiral Arentsen—would that be your area, Captain Rivera?

Captain RIVERA. Yes.

Mr. ROGERS. They had no record of him, not only not being exposed to anything, but not even being on the ship. I thought we were pretty good at keeping records on that. Could you check that for us and let us know? I will give you this information.

Admiral RICKOVER. Yes, sir.

[The following information was received for the record:]

A review of the records at the Bureau of Medicine and Surgery revealed that Mr. Fred A. Nelson was stationed aboard the U.S.S. *Oriskany* from January 29, 1960, to May 6, 1961. The Navy is attempting to locate additional information concerning

Mr. Nelson and any such information will be transmitted to the committee by March 28, 1978.

Mr. ROGERS. He developed cancer right after what he claimed was an exposure to plutonium and this enriched uranium, he developed that shortly after he was separated. I think we need to have that checked.

The committee had made inquiry as to the memoranda, or the memorandum that may have gone between Portsmouth, the Navy, DOE, regarding this entire problem, starting in December. I do not believe we received all the memoranda. I know some were delivered to us, but I think not all. I think if you could check with us on that because it refers to certain other pieces of information.

Mr. MILES. You have everything from our records, sir. Are you looking for staff reports and things like that?

Mr. ROGERS. Yes.

Mr. MILES. I deal with my boss on a face-to-face basis almost hourly, we do not write lots of staff reports and things like that. You have everything in our files on that study.

Mr. ROGERS. What about your dealings with the Department of Energy?

Mr. MILES. You have our letter to the Department of Energy.

Mr. ROGERS. And that is the complete file?

Mr. MILES. That letter records the trip that I made out there to sit and talk with them on the 13th of December; that is all there has been. There have been no reports subsequently; there have been no internal trip reports; there is nothing except that letter.

Mr. ROGERS. That is all you have done with the Department of Energy.

Mr. MILES. I talked to my boss about it in great detail.

Mr. ROGERS. I am going to have to interrupt just for a minute, we do have a vote. The committee will have to recess for 10 minutes, and we will conclude as soon as we can.

The committee stands in recess for 10 minutes.

[Brief recess.]

Mr. ROGERS. The subcommittee will come to order.

I think perhaps the Chair should make clear, the Navy wanted it made clear that in response to the question as to whether you would make all information available to CDC, I think you wanted it clear that it was pertaining to the health-study effects of radiation on workers or naval personnel.

Admiral RICKOVER. Thank you, sir, that is correct.

Mr. ROGERS. Now, let me ask you this. First of all, Admiral Rickover, do you also hold a position with the Department of Energy?

Admiral RICKOVER. Yes, sir. My primary duty is in the Department of Energy; I have additional duty in the Navy Department, really one program because the Energy Department has overall responsibility over reactors and their safety, and so on. So it must necessarily be that way. That is typical of many of the large projects that are coming up in this modern age, it is almost impossible for any one agency to do it directly. I recognized that in 1947, and it started that way.

Mr. ROGERS. What is your position with the Department of Energy?

Admiral Rickover. To tell you the truth, I do not know.

Mr. Rogers. Maybe Mr. Miles knows.

Admiral Rickover. I tell you what I think it is. I am in charge of nuclear propulsion for Navy ships, and also for the first central station plant, the shipping port reactor which, as you know, is the first light-water breeder which is operating right now. The reason is, it uses water technology, and we have had more experience with water technology and reactors, probably, than anyone in the world, any group in the world.

Mr. Rogers. How much of your time can you devote, do you have a division of time, or how does that work?

Admiral Rickover. No; I do everything, regardless of the time. Naturally it is mostly on the Navy because we have 120 ships in operation. I get regular reports very fast on everything that goes wrong on any ship, the training, and so on. I take care, I am responsible for the propulsion plants of nuclear ships and also for the selection, the training of people. We train these people in our own schools, we do not use the Navy system; it would not work.

Mr. Rogers. Yes. And how much time do you devote to the nuclear work with the Department of Energy?

Admiral Rickover. Well, the Department of Energy is involved in nuclear matters, too. So, I do not think you can make a line of distinction. It is all mixed up. How much loyalty does your wife owe to you, and how much to the children?

Mr. Rogers. Well, I think we could divide it. Maybe she has. But you do not have a separate office over there.

Admiral Rickover. No, no.

Mr. Rogers. Do you have separate staff to handle DOE?

Admiral Rickover. No, sir, one staff. That is the most economical way to do it. Again, I suggest this is a darned good way to look at a lot of Government programs instead of setting up two offices, you combine it in one, and you get greater expertise; you share all the information. It is much simpler that way.

Mr. Rogers. Well, I just wanted to be clear in my mind how that operates. So, you operate in your office in the Navy, but you have this position that you hold with Energy.

Admiral Rickover. I have an office in the Energy building, too; we operate in both places.

Mr. Rogers. Well, that is what I am trying to say, you also have a staff there?

Admiral Rickover. No, one staff.

Mr. Rogers. One staff, and none are on the Energy payroll and others on the Navy's.

Admiral Rickover. Some are on the Energy payroll, some are on the Navy's.

Mr. Rogers. That is what I wanted to know.

Admiral Rickover. Some are military, some are civilian. I do not know who they are.

Mr. Rogers. Who does know?

Admiral Rickover. I guess we have a record.

Mr. Rogers. Well, I would hope so, Admiral. I do not want to appear to be absurd, but you are talking now to a committee of the Congress and we are asking how you operate. Now, I would hope you would be responsive.

Admiral Rickover. Yes, sir.

Mr. Rogers. And if not, I want someone who can be.

Admiral Rickover. Well, I am really being as responsive as I can.

Mr. Rogers. Well, I have not anticipated that in your answers to my questions. You told me it was all one staff. Now I find it is paid by the Department of Energy. All right, some of your people are paid by Navy.

Admiral Rickover. Yes, sir.

Mr. Rogers. Now, I do not consider that the same staff.

Admiral Rickover. Well, I am sorry, they do operate——

Mr. Rogers. I understand, they operate under you.

Admiral Rickover. No; they operate under others, also.

Mr. Rogers. Well, then I want to know who they are, that is exactly what I am getting at. If it is separate, I want to know that.

Admiral Rickover. They are not separate, sir.

Mr. Rogers. All right, then put it down on the record, I want to know who they are.

Admiral Rickover. Do you want their names?

Mr. Rogers. I do. I want their names, their salaries, and who pays them; and their duties.

Admiral Rickover. I will do that, sir.

[The information requested can be found in the subcommittee files.]

Mr. Rogers. Now, you know, I want to be reasonable, but I do want answers to questions.

Now, let me ask this, why did the Navy choose the Department of Energy to conduct a study of the possible increased incidence of cancer among shipyard workers exposed to low-level radiation?

Admiral Rickover. Because we do not have that expertise in the Navy, and it does exist in the Department of Energy. They have people who are involved in it, we do not have such people. We depend for many functions on other parts of the Navy and other parts of the Energy Department. We use those instead of building up a staff in our own organization. We try to keep it at a minimum and use the existing organizations.

Mr. Rogers. Now, I understood you were not going to really have the Department of Energy do it, but have them contract with someone.

Admiral Rickover. Well, that is up to them, sir.

Mr. Rogers. Well, I understand it was negotiated with your people.

Admiral Rickover. The Department of Energy has people who head up this work. They do not have enough people to conduct such a study themselves. So, they are going outside to get people to do it.

Mr. Rogers. Well, this is strange to me why you did not just go to the Department of HEW in the first place, where we have expertise already built up in CDC. Why go to an energy-oriented agency to study health effects when we have the expertise in the Department of HEW?

Admiral Rickover. The Energy Department will not conduct this study; they are going to a disinterested group of outsiders

Mr. ROGERS. Well, then, why go to Energy? Why not go to an in-house CDC and save the cost to the Government?

Admiral RICKOVER. We have no in-house.

Mr. ROGERS. Our CDC does, sir.

Admiral RICKOVER. Well, I am not familiar with CDC.

Mr. ROGERS. Well, Mr. Miles, are not you familiar, you are assistant to the admiral? How about you, Captain, are you not familiar with the expertise of the CDC in this area?

Mr. Miles.

Mr. MILES. The Department of Energy has an ongoing 12-year program working on low radiation effects; that is what I was familiar with. I am not familiar with any work that the CDC has done for a long period of time on radiation effects, low-level radiation effects.

Mr. ROGERS. Are you talking about the Mancuso study?

Mr. MILES. Yes, sir.

Mr. ROGERS. Which was terminated by the Department of Energy, and switched all around now. They gave that—I do not know if you are aware of it—but they gave the contract over to a group now where the man that made the judgment to terminate the contract is now working for the group they gave it to. That is of concern to me and this committee. You are not aware of that.

Mr. MILES. I am aware of that. The arrangement from the very beginning of this was that the study would not be done by Navy employees; it would not be done by Department of Energy employees. It would be done by a university.

Mr. ROGERS. Well, then, why did you go there? Why did you not go to CDC?

Mr. MILES. CDC is not a university, it is not independent from the U.S. Government. The issue was to have something independent from the U.S. Government to lead this study.

Mr. ROGERS. Well, then, why did you have to go, may I ask, to the Department of Energy; why could you not have done that directly? Did you have to have the Department of Energy tell you whom to contract with?

Our concern is, and I will say it frankly, is that it appears that there are certain echelons that want to keep all of the energy study within the energy community of the Government. Now, here is the CDC, it is doing Smokey—I guess you are aware of that, Mr. Miles.

Mr. MILES. Yes, sir.

Mr. ROGERS. Doing Smokey, showing what is happening there, health effects from a health-oriented agency, epidemiologists, expert scientists, and you ingnore that. Captain, are you not aware of the expertise of CDC, Captain Rivera? Did you have any judgment on who would do the study?

Captain RIVERA. I was satisfied with the selection.

Mr. ROGERS. Well, who did it, who made the judgment on the study?

Captain RIVERA. The Naval Reactors Office.

Mr. ROGERS. Who is that?

Captain RIVERA. Mr. Miles.

Mr. ROGERS. Did you advise him, Mr. Miles, did you ask Captain Rivera for this advice as to who should do it?

Mr. Miles. I discussed it with him, yes, sir.

Mr. Rogers. Before the decisions was made?

Mr. Miles. Yes, sir.

Mr. Rogers. And what did he advise you?

Mr. Miles. He had no advice, he had no disagreement with that approach.

Mr. Rogers. Well, did you tell him what the approach was before you asked for advice?

Mr. Miles. Simultaneously.

Mr. Rogers. Well, that is a pretty good trick, too. Well, now, who is DOE contracting with for this study, Mr. Miles?

Mr. Miles. They have not contracted it yet, Mr. Rogers.

Mr. Rogers. Who is being considered, Mr. Miles?

Mr. Miles. The meeting I attended with DOE last week, it was with Johns Hopkins University.

Mr. Rogers. To have Johns Hopkins do it?

Mr. Miles. That is a possibility.

Mr. Rogers. Who else, anyone else?

Mr. Miles. They have talked to other people.

Mr. Rogers. Who are they?

Mr. Miles. I suggest you talk to the Department of Energy people who are here.

Mr. Rogers. You are not aware of that?

Mr. Miles. It is their study, not the Navy's. It is a different part of the Department of Energy, a different Assistant Secretary of Energy than we are under.

Mr. Rogers. Let me ask you this, we got a letter from the Secretary of the Navy, dated February 24, which says:

> "The Navy has, since December 1977, been negotiating with the Department of Energy to have initiated a study by a competent and independent agency of records of Portsmouth Naval Shipyard workers. I anticipate that these arrangements will be finalized shortly.

Now, you are not in those negotiations?

Mr. Miles. Yes, sir.

Mr. Rogers. What are those negotiations?

Mr. Miles. They started with a meeting on December 13 in the Department of Energy. We talked about how to do this.

Mr. Rogers. With whom did you discuss that?

Mr. Miles. Dr. Weyzen.

Mr. Rogers. Dr. Weyzen and you had the conference.

Mr. Miles. That is right.

Mr. Rogers. Anybody else?

Mr. Miles. One of my people.

Mr. Rogers. Who was that, sir?

Mr. Miles. Mr. Kindly of my staff.

Mr. Rogers. Your staff. Anybody from Dr. Weyzen's staff?

Mr. Miles. He had a consultant from Oak Ridge come in for part of the session about one specific type of study.

Mr. Rogers. Could you tell me who that was?

Mr. Miles. Cliff Patrick.

Mr. Rogers. Cliff Patrick. Is he with——

Mr. Miles. Oak Ridge Associated Universities.

Mr. Rogers. The universities.

Mr. MILES. And he had also Dr. Albers of the Operational Safety Staff of the Department of Energy .

Mr. ROGERS. Now, who initiated the meeting?

Mr. MILES. I did.

Mr. ROGERS. What will be the terms of payment, will you pay for it?

Mr. MILES. No, sir.

Mr. ROGERS. You mean the Department of Energy is going to pay for it out of their budget?

Mr. MILES. Yes, sir.

Mr. ROGERS. What made them agree to do that, has that been agreed upon?

Mr. MILES. Yes, sir.

Mr. ROGERS. And they will undertake the study for you?

Mr. MILES. No, for themselves.

Mr. ROGERS. So, it is their study, and not yours.

Mr. MILES. That is correct. The Navy provides the data on the workers.

Mr. ROGERS. But no money to provide the study.

Mr. MILES. No money. If you provided Navy money it would taint the survey, of course.

Mr. ROGERS. That might be true—I would hope not, but it might be true.

Mr. MILES. It might seem that way to people looking at it.

Mr. ROGERS. That is correct.

Mr. MILES. That is why no Navy people are dong it and no Department of Energy People are doing it.

Mr. ROGERS. Did you have any discussions with CDC or the Department of HEW?

Mr. MILES. No, sir.

Mr. ROGERS. Did it ever cross your mind that there might be a competency there?

Mr. MILES. I am not an epidemiologist, I did not do the survey of the country's capability to do an epidemiological study; it was a Department of Energy study. I approached them with a set of data from the navy shipyards and a set of worries that have been building up for a long time.

Mr. ROGERS. And there were no memos of that meeting?

Mr. MILES. Yes, there is a memo of it.

Mr. ROGERS. Just the one.

Mr. MILES. The memo Admiral Rickover signed on December 30, that records that December 13 meeting.

Mr. ROGERS. And that is the only memo.

Mr. MILES. That is the only memo on that meeting.

Mr. ROGERS. And what is the data that you have turned over or agreed to turn over to them, that you went to them with?

Mr. MILES. What I went to them with was the kind of data we have been talking about here, how many people——

Mr. ROGERS. No, what I am saying is, did you take with you——

Mr. MILES. What I took to them was a description of the problem. Here is the population at risk, here is their exposure, here is how many years, here is what kinds of problems, here is the technical background for it. Is this of interest, is it a clean, clear situation that one could do an intelligent study on that would come up with clear results. You cannot get an answer to that right away. The conclusion was, they had better go look on site.

So, they put some expert epidemiologists, industrial hygienists, M.D.'s in radiation medicine to take a look at our whole radiation health program, which they did subsequently at a shipyard to go see, could this be done well.

Mr. ROGERS. Now, Let me ask you this, what study did you actually take with you to point up this problem?

Mr. MILES. The data we talked today, how many rem per worker, how many workers——

Mr. ROGERS. I thought you told me, the Navy has said you do not have any problem.

Mr. MILES. No, sir.

Mr. ROGERS. Pardon?

Mr. MILES. That kind of terminology just does not match my vocabulary.

Mr. ROGERS. I thought that is what you assured the workers, put out by Captain McDonough. Did you not put out a letter saying there was no problem?

Captain MCDONOUGH. I put out a letter, it did not say there was no problem.

Mr. ROGERS. Well, what was the thrust of it to the employees, Captain?

Captain MCDONOUGH. The thrust of my letter to the employees was that the information contained in the Navy statement was the best that we had, and that we did not want the workers to be unduly frightened by the data that they had read in the newspaper.

Mr. ROGERS. Well, as I recall, you say something about it, 1 in 10,000.

Captain MCDONOUGH. That is the Navy's statement, yes, sir.

Mr. ROGERS. Did you get clearance of that before you issued it?

Captain MCDONOUGH. Yes, sir.

Mr. ROGERS. From whom?

Captain MCDONOUGH. From my headquarters in Washington.

Mr. ROGERS. And who is that?

Captain MCDONOUGH. COMNAVSEAC.

Mr. ROGERS. And who is that?

Captain MCDONOUGH. The Commander of the Naval Sea Systems Command is Vice Admiral Bryan.

Mr. ROGERS. Did Mr. Miles give you a clearance?

Captain MCDONOUGH. No, it was not from him, it was cleared all the way up in the Navy.

Mr. ROGERS. Did you discuss it with him?

Captain MCDONOUGH. Yes, sir.

Mr. ROGERS. Did you make any memorandum of that discussion?

Captain MCDONOUGH. No, not other than what you have been given, sir.

Mr. ROGERS. Pardon?

Captain MCDONOUGH. Other than what was given to you I have not. The Navy's statement was cleared up to the Secretary of the Navy, and I was informed that it was cleared by the Secretary of the Navy, and that it was being released.

Mr. ROGERS. Then that was the Navy's position?

Captain McDonough. Yes, sir.

Mr. Rogers. Then that must be your position, Mr. Miles; is it?

Mr. Miles. Yes, sir.

Admiral Rickover. And that is my position, that the position we drew up be cleared through all the channels in the Navy right up to the Secretary of the Navy.

Mr. Rogers. So, the Secretary himself has approved that.

Admiral Rickover. Yes. That statement—I believe you have a copy——

Mr. Rogers. Yes; I do have a copy.

Admiral Rickover [continuing]. That was cleared by the Secretary of the Navy.

Mr. Rogers. Because that gives the impression that there is basically no problem for the workers. Now, let me ask this, did you take the Boston Globe newspaper accounts over to the meeting?

Mr. Miles. No, sir. There were no Boston Globe newspaper accounts. The meeting was on the 13th of December. The first Boston Globe queries came in after that.

Mr. Rogers. Did you see any newspaper articles on that, that you took with you?

Mr. Miles. I did not. I had newspaper articles before that meeting, Dr. Najarian's meeting in Dover, N.H., on December 7. That was a straw in considering having that December 13 meeting. It was arranged after that December 7 meeting.

Mr. Rogers. In other words, your meeting was triggered, then, by the Najarian efforts?

Mr. Miles. The meeting was triggered by the report which I did not get until the first week of December, of the Mancuso study on the Hanford radiation workers. That was the main trigger for this study. Dr. Najarian's meeting was one more straw. That was considered.

Mr. Rogers. Then why did you decide Portsmouth rather than Charleston?

Mr. Miles. We are doing it everywhere, sir.

Mr. Rogers. That does not answer my question. You first recommended in your letter that it be done at Charleston.

Mr. Miles. Charleston was a convenient place—that letter talks about a feasibility study.

Mr. Rogers. I understand.

Mr. Miles. Charleston was a convenient place that had enough time to spare to go do that feasibility study.

Mr. Rogers. Then why was it changed to Portsmouth?

Mr. Miles. The first meeting was held at Charleston. Portsmouth got in there because they had the first overhaul. The last meeting we had at Johns Hopkins, we talked about doing Portsmouth and Mare Island simultaneously as the first, and the other four Navy yards to follow very closely. You have to start somewhere with the data.

Mr. Markey. Would the gentleman yield for a second?

Mr. Rogers. Certainly, I will yield.

Mr. Markey. Could I ask if on the date of that meeting you knew that not only Dr. Najarian, but also the Boston Globe spotlight team was investigating the Portsmouth Shipyard? Did you have knowledge of that at the time?

Mr. MILES. I knew nothing about the Boston Globe on the 13th of December.

Admiral RICKOVER. No, sir. That was triggered by the report from Hanford; that was the initial start. As Mr. Miles said, the subsequent stuff helped trigger it. That is one of the reasons why we want to go to Portsmouth because that is in the limelight. But we had expected all along to go to all the Navy yards, not only Portsmouth, all the others. As Mr. Miles said, the original plan was to take two at a time. There was Charleston and Mare Island.

Mr. MARKEY. I am just trying to figure out, was the chicken or the egg first, because Dr. Najarian had contacted the Navy on October 4, and he circulated the questionnaires by November 4.

Admiral RICKOVER. Well, the thing that triggered it was the Hanford report.

Mr. MILES. Let me answer that, if I may, please.

If you go back to Dr. Najarian's first discussions, I followed them on a daily basis. I talked with the shipyard from the very first contact Dr. Najarian had, from the first contact the patient's family and the patient's doctor had with the shipyard. I met with Senator McIntyre's staff on the 14th of December, which Senator McIntyre mentioned this morning in his statement. By that time the only issue at Portsmouth was one man who maybe had aplastic anemia, who had a known total lifetime exposure of 1.53 rem. Everything else came later. There were no other cancer cases; there was no other issue.

At that point, is there a problem at Portsmouth? On that issue it was very clear. There was one man with possible aplastic anemia, which is not yet cancer; his total exposure was 1.53 rem. That is as close as I can come to saying, "Hey, there is no problem here yet. There is a problem with that person," and we made sure the yard responded to that promptly. They gave the family, the private doctor, and the Veterans' Administration hospital all the details they had on the patient right away.

Mr. MARKEY. Well, not that individual case, but earlier testimony indicated that calls had come from family members indicating their displeasure with the spotlight team making inquiry as far as cancer-related deaths. I mean, I am just talking now about your knowledge———

Mr. MILES. That was after mid-December, Mr. Markey.

Mr. MARKEY. No calls came before mid-December?

Mr. MILES. No, sir. The spotlight team was not working on that issue before then, as far as I know.

Captain McDONOUGH. My first call was on December 14, questions from the Boston Globe spotlight team. We did not know it was the spotlight team, just that it was the Boston Globe at the time.

Mr. ROGERS. Now, what about the admission of NIOSH-OSHA, are they admitted to the shipyard, OSHA teams?

Admiral RICKOVER. Yes; they come in all shipyards all the time.

Mr. ROGERS. So, there is no problem there.

Admiral RICKOVER. No. There has been a problem listed in the newspaper, and I talked with the Deputy Secretary of Labor yesterday, and he agreed. He and I had a meeting and discussed it, and it was very amicably conducted. He agreed last night, Mr. Whiting, on the phone.

Mr. MILES. Mr. Rogers, you said both NIOSH and OSHA. The admiral is talking about OSHA.

Mr. ROGERS. OSHA, I am sorry.

Admiral RICKOVER. Is that all right, if I talk about OSHA?

Mr. ROGERS. Yes.

Admiral RICKOVER. I can give you better information. I had a meeting with Secretary Marshall and his assistant, Mr. Whiting, some time ago, Mr. Wegner, my deputy and I did, and we discussed the operation of OSHA in some of our shipyards. As a result of that, we have had very fine discussions with Mr. Whiting and his assistants. As a result of these meetings we have come to better understandings and methods of cooperation. We do not know of any problem although discussions are continuing. There appear to be some people who are handing out information which is agreed to by the agency; that happens quite frequently in Washington.

Mr. ROGERS. Well, J. D. Chase, rear admiral, U.S. Navy, in a memo states:

> Navy advances the position that neither the provisions of section 19 of the OSHA Act nor the Executive Order No. 11807 were intended to cover military personnel.

I did not know if that was followed throughout the Navy.

Admiral RICKOVER. I can talk specifically of a nuclear submarine. The reactor plant I think, is not totally subject to OSHA. On the other hand, other parts of the ship are subject to OSHA. This is something we are working out with them. For example, there comes to be a question of some riggers on deck doing something or other, all we ask, not that we notify the contractor—that is against the law, you cannot tell the contractor that OSHA is coming in. But we have to know, and we authorize it. The fine is $1,000 for anyone who gives advance notification to a contractor that an OSHA representative is coming in. We are not going to do that.

Mr. ROGERS. Now, if we can get back now to this study that you have asked the Department of Energy to do. Let me ask you this, Admiral, does the Department of Energy pay a salary to you for your duties?

Admiral RICKOVER. No; I am a naval officer, consequently I get paid by the Navy. Since you raised that question, you must remember, sir, that the work we do, first the law provides that my organization shall be in the Energy Department. I do not know if you are familiar with that. That is right in the Energy Act; it is part of the law. I have additional duty in the Defense Department.

Mr. ROGERS. Yes.

Admiral RICKOVER. And the reason I could not answer you exactly about the employees, everybody in the organization works both on the Energy matters and on the Navy matters. We make no distinction.

Mr. ROGERS. Well, I want to know who gets paid by whom.

Admiral RICKOVER. I said I will give you that. Is it all right if I give you the numbers of people?

Mr. ROGERS. No; I want the names.

Admiral RICKOVER. We will give you the names.

Mr. **Rogers**. Now, let me ask this, has it been determined how much the study will cost, Mr. Miles?

Mr. **Miles**. No, sir—maybe the Department of Energy has.

Mr. **Rogers**. I will get to them, but as far as you know. Has any time element been discussed, as to how long it would take?

Mr. **Miles**. Yes, sir. Several of these discussions talked about time.

Mr. **Rogers**. And the only name you know on the study under consideration was Johns Hopkins?

Mr. **Miles**. No, there were other names mentioned.

Mr. **Rogers**. And you said Oak Ridge.

Mr. **Miles**. Harvard was mentioned. Now, the reason for Oak Ridge and the Hanford Environmental Health Foundation being on that first scoping study, were to use their intelligence and experience in doing this kind of study to help advise, to see what kinds of records to get started with, if any, could you do it; to get an independent review of our whole radiation health program to find out what else we are doing wrong. It was a broader review.

Mr. **Rogers**. Now, it is my understanding that you will furnish any records they would need for that study, if it is contracted out.

Mr. **Miles**. Yes, sir.

Mr. **Rogers**. And you would not be involved in the design or the determination of protocol.

Mr. **Miles**. Absolutely not. They have not even agreed to let me see the protocol.

Mr. **Rogers**. Yes. Now, as I understand it, you keep all exposure records, but your medical health records are kept for 3 years.

Captain **McDonough**. No, sir, we keep the medical health records for employees the whole time we have them. When an employee retires, or leaves, they are put into the archives. The man, of course, is provided when he leaves with his radiation history.

Mr. **Rogers**. His exposure record.

Now, I think you previously told us about the overhaul of the nuclear submarine *Nautilus* were six people had been sprayed with water.

Admiral **Rickover**. You mentioned that, that six had been sprayed with water. Mr. Miles is familiar with that.

Mr. **Miles**. I think it is Captain McDonough.

Mr. **Rogers**. All right, Captain McDonough.

Captain **McDonough**. The incident that they referred to, which was in the paper, concerning a ruptured hose, we do not have a record of that incident. The newspaper identified the machinist who was supposed to have been thoroughly wetted. We do have the full record on that individual in the detailed records that we keep.

Mr. **Rogers**. When did this occur, sir?

Captain **McDonough**. The incident that this man put in a claim for occurred at 12:30 on December 23, 1959.

Mr. **Rogers**. But you have no record that it occurred.

Captain **McDonough**. We do not have a record of any hose rupturing. We have a record that this man got himself contaminated by leaning against a steam generator; his face and shirt were contaminated.

Mr. **Rogers**. You have no record of six men having been sprayed?

Captain **McDonough**. No, sir, we do not have that. We are trying to get more data. We are still conducting this investigation because when we got this man's name, Mr. Grivois, Alphie Grivois, it gave us a way to go. We went into it, and I have his total record of exposure by time, date, what he did.

Mr. **Rogers**. When did you get his record?

Captain **McDonough**. Sometime late last week, after he was identified in the Globe. I personally saw it yesterday completely. In his record, including his claim, he identifies two witnesses to his incident. We have contacted those witnesses, and we are trying to get the names of the other people who were involved or on the job. We do not know that any were wetted. If we can identify them we can pursue their records.

I have very, very detailed exposure records and job history of the man, right down to the minute, the day, and how much exposure he received in each and every instance.

Mr. **Rogers**. Yes; I think we have a witness.

Captain **McDonough**. Yes, Mr. Belhumeur.

Mr. **Rogers**. Mr. Belhumeur, who will explain his knowledge about it.

Captain **McDonough**. I do not think what Mr. Belhumeur is talking about is the same incident as what I have. The man identified, Mr. Grivois, in his claim says it was not a hose rupturing, it was surface contamination that he touched, picked up on his shoulder and face. It does not indicate a hose rupture in any place, we have no record of it. That is why we are trying to get the other names so we can go into their records and trace that out. I have a memorandum that is written on the 24th of December, Christmas Eve, 1959, which states what happened to Mr. Grivois. If you like, I will read it.

Mr. **Rogers**. No; I do not think that is necessary, if you would put it in the record, that would be helpful, please.

So, you do not think they are the same incidents.

Captain **McDonough**. No, sir, I do not. I spoke with Mr. Belhumeur a few moments ago, and he said the situation he is talking about definitely consisted of water. This same man, Mr. Grivois, I went to his records—we went to his records—and we went through them and find that he submitted a claim for compensation because of a cancer that he had developed; and he cited in his claim an incident occurring on the 23rd of December 1959. We go to our records and we can identify that. It is not the same description.

Mr. **Markey**. Mr Chairman?

Mr. **Rogers**. Yes, Mr. Markey.

Mr. **Markey**. The Navy claims that each employee is informed of his radiation exposure. Yet, the unions tell us that the workers have no personal records of exposure, nor do the unions. Will the Navy provide those records for the union, or for the individuals; or do you dispute that contention?

Captain **McDonough**. I do not think we are talking about the same thing. From 1959 on, information was available to each worker on his annual exposure. Presently every day when a man goes to work his annual exposure record is presented to him, he has to write this information on the card that he uses to draw his radiation measuring device.

Mr. MARKEY. And the unions are given that same information?

Captain McDONOUGH. We do not distribute it to the unions. It is put at the work sites and the union representatives go in there. It is available information.

Mr. MARKEY. I just wanted to make sure.

Mr. MILES. We did measure their daily exposure in 1959. They could see it any day and were required to look at it every day from 1959 on, when we started work at Portsmouth. However the worker is not given a paper with his exposure on it until termination of employment unless he asks for it.

Mr. MARKEY. I just wanted to make sure that is the case because I have heard reports that is not the case.

Captain McDONOUGH. We do not distribute that data to the union.

Mr. MARKEY. The unions do not get that information, it is strictly to the individual.

Captain McDONOUGH. To the individual.

Mr. MARKEY. Do you think the unions might be able, as a data bank, to give the personnel an interpretation of what their exposure levels mean? They might be able to use them as a resource, also, as well as a repository for that information?

Captain McDONOUGH. Well, I do not think they have the resources to do it. We have it. We have it in a computer, we print it out every day; and we have a trained office, the Radiological Control Office, to answer any question that any man has. We encourage them, "If you have questions, come and see us, we will sit down." We give them time off the job to do this, to sit down with trained people in the Radiological Control Office, to go over exactly what it is so the man understands what it is.

Mr. MARKEY. Thank you, Mr. Chairman.

Mr. ROGERS. Now, Admiral, I would hope that we could—and I would like to put that on the record—have all memos and correspondence involving Portsmouth or other shipyards, or matters relating to the subject of radiation as it pertains to the health in the nuclear shipyards.

Admiral RICKOVER. Mr. Miles says that is thousands of cubic feet.

Mr. ROGERS. What if we limited it to Portsmouth?

Mr. MILES. Yes, sir.

Mr. ROGERS. There would be how much?

Mr. MILES. You said everything related to radiation.

Mr. ROGERS. Memos and correspondence involving the subject of radiation as it pertains to human health.

Mr. MILES. I do not know how to define that. Every radiation measurement made in the shipyard, there are 100 pages a day in Portsmouth of radiation survey files alone.

Mr. ROGERS. I think what we are trying to get at is the memoranda in making decisions as to what to do about the health radiation matter as it pertains to Portsmouth or other shipyards.

Mr. MILES. I guess I do not understand that question, I do not know how to define it. You are talking about Dr. Najarian's study?

Mr. ROGERS. That would be one.

Mr. MILES. You have all of that. If you are talking about the Department of Energy study on mortality of shipyard radiation workers, there have been no memos to the shipyards; there is nothing in their files that headquarters has provided them on that study.

Mr. ROGERS. And the only letter has been the one letter from you, Captain McDonough? Well, I do not even see a letter to Mr. Miles or Admiral Rickover, or a memo on this problem. Was there?

Captain MCDONOUGH. No, sir, we kept them cut in on the questions that were received.

Mr. ROGERS. How do you keep them cut in?

Captain MCDONOUGH. On the telephone, sir.

Mr. ROGERS. Everything is done by phone?

Captain MCDONOUGH. Well, virtually, and we use Telefax.

Mr. ROGERS. I notice you did send out a little memo to the other commanders of the Navy shipyards.

Captain MCDONOUGH. Yes, sir. After the fact I have compiled all information I had and sent it to the commanding officers of the other shipyards. These are people who have the same type of problems I have because the subject is one, as we have heard today, that deals with all the shipyards. We happen to be the focal point now.

Mr. ROGERS. Yes; I understand.

Captain MCDONOUGH. Questions crop up in other yards virtually as soon as they crop up in Portsmouth. I sent that memo to Mr. Miles, too.

Mr. ROGERS. You did not have to get a clearance for that?

Captain MCDONOUGH. All I did was put a cover on the stuff we had already published, or that had been published in the Boston Globe.

Mr. ROGERS. But you see, I got no memorandum of your asking for clearance, or your getting clearance for anything. There was none?

Mr. MILES. No, sir.

Mr. ROGERS. I thought you said you got clearance before you put out your release.

Captain MCDONOUGH. The Navy statement to which we offered some input to Washington——

Mr. ROGERS. And it was approved by Mr. Miles, you told me.

Captain MCDONOUGH. The Navy statement was then sent out to various naval activities, the Chief of Naval Information in Boston——

Mr. ROGERS. On the phone?

Captain MCDONOUGH. It came over the Telefax, a copy of it.

Mr. ROGERS. Then you have a memo.

Captain MCDONOUGH. I have a Telefax copy of the Navy-approved statement.

Mr. ROGERS. Did you send anything in before it was approved on the Telefax?

Captain MCDONOUGH. Parts of it I sent down, a proposition. I proposed to answer a question this way—and I sent that down. The Navy statement, then, in response to the Boston Globe's article was prepared in Washington, approved by the Secretary of the Navy——

Mr. ROGERS. That is what I want. Why were not those memos furnished, Mr. Miles?

Captain MCDONOUGH. That is the Navy's statement, Mr. Rogers.

Mr. ROGERS. I wanted a memo from you to Mr. Miles.

Mr. MILES. There is none.

Mr. ROGERS. He said he sent you part of the information.

Mr. MILES. He sent questions and answers for the Boston Globe articles, is what you are talking about; that is what he was answering.

Mr. ROGERS. You had no other communication on this subject matter in writing with headquarters?

Captain MCDONOUGH. No, sir; the questions and proposed answers.

Mr. ROGERS. That was the only thing that was put in writing?

Mr. MILES. That is right.

Mr. ROGERS. Now, what about the actual release given, I thought you got a clearance on that release.

Captain MCDONOUGH. The Navy statement was Telefaxed to me, and I was told the Secretary of the Navy said to release it.

Mr. ROGERS. Did you have any input into that?

Captain MCDONOUGH. Yes, sir.

Mr. ROGERS. How did you give that input?

Captain MCDONOUGH. In the proposed questions and answers, the part of the Navy's statement that talks about, death in an automobile, 1 in 4,000; normal industrial risk, 1 in 10,000; that paragraph we prepared and had sent down as part of an answer to a question. It was put together as part of the Navy's statement, the lengthy statement that the Navy issued.

Mr. ROGERS. Well, then, have you released publicly all of the questions and answers as you propose them to the Navy?

Captain MCDONOUGH. No, sir.

Mr. ROGERS. Do we have that memorandum?

Mr. MILES. There is no such thing.

Mr. ROGERS. He just said he sent you one.

Mr. MILES. You are talking about the working papers.

Mr. ROGERS. That is exactly what I am talking about.

Mr. MILES. It was on the telephone, working out the questions and answers.

Mr. ROGERS. I am talking about the paper he sent you, a memo, as to suggested answers to possible questions.

Mr. MILES. I do not have it.

Mr. ROGERS. Where is it?

Mr. MILES. Do you have a copy?

Captain MCDONOUGH. No, sir.

Mr. ROGERS. What happened to your copy?

Captain MCDONOUGH. Let me explain it, Mr. Chairman.

Mr. ROGERS. I would like for you to.

Captain MCDONOUGH. I get a question on the telephone from the Boston Globe, and I try to come up with a proposed answer. I then Telefax that to headquarters in Washington. It gets messaged and comes back, as the question and answer. At which time whatever I submitted I throw away, and I have an answer which we then mail to the Boston Globe. I have copies of that, if that is what you want.

Mr. MILES. The committee has that. The committee has all those questions and answers; that is what was bundled up. The drafts of those, we threw them away as fast as they were written.

Mr. ROGERS. All of the suggested proposals?

Captain McDONOUGH. Yes, sir.

Mr. MILES. There were several hundred questions that we have been through in the last several weeks around our world. All we have left in our files are the answers.

Mr. ROGERS. I notice you say in your letter, Captain, you said:

> I am forwarding some of this information on radiation queries received, and replies I have provided. To keep you informed and to provide you with the approved, authorized replies I have made, I am forwarding this packet. Hopefully you will not need it, but if you do, I think your use of some of my replies can expedite clearance of your replies, and most importantly, maintain a degree of consistency.

Captain McDONOUGH. Yes, sir.

Mr. ROGERS. Now, are you telling me this was all done by telephone?

Captain McDONOUGH. What you are reading from, Mr. Chairman, I think was my memorandum to the other shipyard commanders.

Mr. ROGERS. That is exactly right.

Captain McDONOUGH. I put one out on the 6th of February.

Mr. ROGERS. I have it in front of me, that is what I read from.

Captain McDONOUGH. That compiles all that I had been involved in up until that time. I sent it to the other shipyard commanders because they receive questions from their local newspapers; they receive questions from their people the same, whenever something is on the wire. My answers I had cleared with my headquarters and felt that it would be a way to expedite them in responding to a similar question. A Navy statement that is issued to answer a question in Portsmouth does not get the widespread coverage in another yard until the question comes up. I took it upon myself to provide it to them, to keep them informed of what was going on in my yard because the problem is one for all of us.

Mr. ROGERS. So, what you did was simply send up Telefax, and it is destroyed——

Captain McDONOUGH. On the questions and answers, yes, sir.

Mr. ROGERS. Any other information you sent to them?

Captain McDONOUGH. I cannot recall anything else.

Mr. ROGERS. You have no records of any, no copies.

Captain McDONOUGH. No, sir. You have everything that I have.

Mr. ROGERS. So, most of that is done by telephone, then, Mr. Miles.

Mr. MILES. That is correct. Some of it is dictated over the phone; some of it is a telecopying machine. We were very fast moving to give good service back to the news queries. They were coming in from port cities all over the country, and they got very fast service. But it does not get done with files and staff memos, and things.

Mr. ROGERS. The Secretary of the Navy said in the Boston Globe on February 19 that he knew nothing about the situation in Portsmouth. How could he have given approval of these?

Mr. MILES. He approved the February 23 statement, sir.

Mr. ROGERS. He had not approved the prior questions and answers?

Mr. MILES. No, sir.

Mr. ROGERS. Why did you sent it to the other—Captain McDonough—the other——

Captain McDONOUGH. The other shipyards?

Mr. ROGERS. The other shipyards. You are not in command of the, are you?

Captain McDONOUGH. No, sir. They are my peers. I am the focal point of a problem, I have a lot of information that would be of use to them; they are involved in the same——

Mr. ROGERS. Were you asked to do that?

Captain McDONOUGH. No, sir, I was not.

Mr. ROGERS. This was just on your own initiative that you decided to send that to them. Were you aware of this, Mr. Pyatt?

Mr. PYATT. No; I was not.

Mr. ROGERS. Do you know anything about these problems?

Mr. PYATT. Well, my exposure to the problem has been in the last few days.

Mr. ROGERS. So, it was really not brought to your attention until the Secretary had it brought to his attention.

Mr. PYATT. No, sir. I was in Saudi Arabia when it first came out. I guess my exposure started the day I got back.

Mr. ROGERS. Now, do you have a record of the answers to the Globe, did you keep that?

Mr. MILES. Yes; we have a record, and the committee was provided our entire file of questions and answers from the Globe.

Mr. ROGERS. Have you had any other questions that you have records of, that you have replied to, regarding health matters?

Mr. MILES. Sure. Every question we have our record of answer to, in those files.

Mr. ROGERS. That we have.

Mr. MILES. I am not sure how much of Hawaii newspapers and Bremerton newspapers, and so on we gave you in that round. I think it was the Globe that you asked for.

Mr. ROGERS. That you restricted the answers to.

Captain McDONOUGH. All of the queries I got.

Mr. ROGERS. Have come to us.

Captain McDONOUGH. Yes, sir.

Mr. MILES. We have all those files of television stations and radio stations, and other newspapers around the country, too. We keep our questions and answers when they are final in a permanent file.

Mr. ROGERS. And the only memorandum concerning this matter is the one that you furnished to the committee.

Mr. MILES. Correct.

Mr. ROGERS. All right. Now, let me ask you this, Admiral, if a study does show that the initial study done by the doctor, Dr. Najarian, is valid—and I understand you would want to have it confirmed—would that indicate to you a necessity for a change of standards for radiation level exposure?

Admiral RICKOVER. Let me repeat the question as I see it. Dr. Najarian comes out with this study—and let us say for the sake of argument it shows we ought to cut in half our radiation standards, and this is finally approved by competent authority, we would try to do that, yes. But we would not take his word for it.

Mr. ROGERS. No; I understand your position that you are saying you would want it confirmed, and I think he has no objection to having his study confirmed; I think there is no question about that. What I am saying is, if that were to be confirmed, I would think you would feel there would be a need for a reduction of those standards, or a tightening up, rather.

Admiral RICKOVER. There would be a need, sir, for a reduction in the national standard. If the people responsible for the national standard decided to lower it, we of course would abide by it, provided in so doing we would not have to lay up the nuclear Navy. That would be a subject for Congress.

Mr. ROGERS. Sure.

Admiral RICKOVER. Absolutely. As I have said a number of times here, we do better than complying with the national standard.

Mr. ROGERS. I think you would want it confirmed, and I think that is what we want CDC to do. The committee intends to get to the facts and then take whatever action is indicated for low-level radiation.

Admiral RICKOVER. I do not believe CDC would be the sole deciding authority, there would have to be others, whoever they are. I do not belong on any of those committees.

Mr. ROGERS. I understand, but I think it would be based on a scientific study.

Admiral RICKOVER. Yes, sir.

Mr. ROGERS. I think that is what we are trying to say.

Admiral RICKOVER. May I repeat what I just said?

Mr. ROGERS. Certainly.

Admiral RICKOVER. If a new national standard is set up which lowers the present radiation tolerance, we of course will abide by it, unless in abiding by it we cannot operate our ships. At that point it will be a matter to come before the Congress.

Mr. ROGERS. Certainly, I understand that.

Admiral RICKOVER. Is that a clear statement?

Mr. ROGERS. Sir, I think that is a fair statement. I know that we have had testimony in prior hearings from Dr. Radford, who is a member of the National Academy of Sciences, and this is a personal opinion so far. He feels that the levels are 10 times too high. That has not come out as an official statement of the peers group; but it is some indication that the scientific thinking, again, believes that we do need to do a study and look at that very carefully.

Admiral RICKOVER. I should add one thing. I tried to make clear in my testimony that a considerable part of radiation is not being considered in this, and that is all radiation, including medical radiation. That must be considered.

Mr. ROGERS. You are certainly correct. We are going to have a look at that as well.

Admiral RICKOVER. That was really my point in getting in a disinterested group which is not obligated to the Government in any way, shape or manner, of recognized scientific competence, to look at that and have that looked at by other peers.

Mr. ROGERS. Yes. We are somewhat concerned about the Department of Energy, but I think it is working out with the CDC, and you have agreed to give full access to information so the study may go forward. I think we have made that clear.

Admiral RICKOVER. And, as you have said, as long as the CDC sticks to this subject.

Mr. ROGERS. Oh, yes. We do not expect them to get into maneuvers of the Navy, or anything like that.

Admiral RICKOVER. Well, we have had some experience, Mr. Chairman.

Mr. ROGERS. Well, I hope not with CDC.

Admiral RICKOVER. With CDC.

Mr. ROGERS. Trying to tell you how to run the ship?

Admiral RICKOVER. No; they get into other areas which are not concerned with the specific investigation.

Mr. ROGERS. Then this committee would like to know about it. Would you let us have a memo on that?

Admiral RICKOVER. If it happens, we will let you know.

Mr. ROGERS. Well, I do not think it has happened to date.

Admiral RICKOVER. Well, I do not think it is going to happen.

Mr. ROGERS. Well, I do not either. If it does, you let me know.

Admiral RICKOVER. As long as you are chairman, I do not think it is going to happen.

Mr. ROGERS. It sure won't.

Admiral, thank you.

Admiral RICKOVER. Thank you, sir.

Mr. ROGERS. Dr. Carter?

Mr. CARTER. There is just one thing I notice on this chart that you gave us, which goes from 1969 up to the present, that the average radiation exposure is 0.3 rem or less per year; is that not correct?

Mr. MILES. That adds in the whole operating forces, too.

Admiral RICKOVER. It takes in everybody.

Mr. CARTER. Sailors and all.

Mr. MILES. This reduces the average. The shipyard people average is a little higher than that.

Mr. CARTER. The shipyard people are included, too, and the average there would be 0.3 rem, or 300 mrem; is that correct?

Mr. MILES. That is about right, about a quarter of a rem a year is the long-term average for the whole program.

Mr. CARTER. And that is less than the 0.5 rem standard which was suggested by Dr. Radford.

Admiral RICKOVER. Yes, sir. I think in general you could say we have taken such extreme care that we are way below, with some unusual cases, we are way below the national standard. The fact that we had a national standard we could reach did not motivate me at all because I think all radiation is bad.

Mr. CARTER. Yes; there is no question about that.

Admiral RICKOVER. We cut that, and we did it long before there was this hue and cry.

Mr. CARTER. Yes, sir. I notice it goes back to 1969.

Admiral RICKOVER. Yes, sir.

Mr. CARTER. Dr. Radford recommended 500 millirem or 0.5 rem per year as the occupational exposure standard.

Admiral RICKOVER. Yes, sir.

Mr. CARTER. And of course you are below that on an average at the present time, as I see it.

Thank you, Mr. Chairman.

Admiral RICKOVER. May I express my appreciation? I deeply appreciate the courteous way you have treated me, you have permitted me to talk very openly, that is a great help, too. I really wish you success in this endeavor and I believe, as I said earlier, you can accomplish a great thing for the United States by pursuing this thing to the bitter end.

Now, I do not know what the outcome is going to be.

Mr. ROGERS. I understand. We appreciate your being here, Admiral, Mr. Pyatt, and your associates; we are grateful to you and we are sorry we had to take so much of your time. It was necessary, I think, to clear the air and make sure the study proceeds without any impediment. I think that is clear on the record.

Admiral RICKOVER. Yes, sir.

Mr. ROGERS. Thank you for your presence.

The next witness is Mr. Ronald Belhumeur of Dover, N.H. Mr. Belhumeur, the committee welcomes you, we will be glad to have you make a statement.

STATEMENT OF ROLAND BELHUMEUR, DOVER, N.H.

Mr. BELHUMEUR. Mr. Chairman, members of the committee, the Senate and the House.

Mr. Chairman, my name is Roland Belhumeur of Dover, N.H. I am a longtime employee of Portsmouth Naval Shipyard, in fact, 29 years, 7 months, and 17 days. I retired on disability because of an injury that happened on the U.S.S. *Sam Rayburn* submarine in 1971.

Mr. ROGERS. Is that a nuclear sub?

Mr. BELHUMEUR. Yes.

Mr. ROGERS. Thank you.

Mr. BELHUMEUR. Mr. Chairman, while working at Portsmouth Naval Shipyard during the last 6 years of the 1950's I became engaged in radiation work aboard the U.S.S. *Nautilus*, and other U.S. subs at Portsmouth Naval Shipyard. during my employment on the *Nautilus* we had what they call a spill of contaminated water from the system which my fellow workers got really belted with contaminated water. We were taken off the boat and taken to a decontaminated area.

Mr. ROGERS. Excuse me, where?

Mr. BELHUMEUR. At Portsmouth.

Mr. ROGERS. At Portsmouth?

Mr. BELHUMEUR. Yes. We had someone look at us, I think it was a doctor that they called in. Later, sent home with Navy fatigues. Mr. Chairman, during my employment at Portsmouth Naval Shipyard I started with radiological decontamination training in June of 1952. Until 1958, when I started decontaminating the gear that was to be used on the U.S.S. *Nautilus* overhaul.

Mr. Chairman, during my employment at Portsmouth Naval Shipyard during 1959 until 1963 the radiation control was run by the Navy. If you had your dosage limits the Navy would give you a waiver and you could get more dosage. This went on and on aboard the *Nautilus*.

Then, in 1963 the radiological started to give alert monthly dosage cards. I feel that the total on February 1963 is way under. We got more radiation on the *Nautilus* than any other boat that came to Portsmouth Naval Shipyard.

Mr. Chairman, I am speaking for myself and also others who got more exposure than they should have. Since the 571 *Nautilus* the levels are very low, but the levels during 1959 to 1963 were high;

the controls were wrong. Dosimeters that they used to give us were off kilter. Mr. Chairman, the reason I am here today, I am concerned about the long-time exposure of radiation because no one would tell you what it does to you.

Mr. Chairman, the group that I worked with aboard the *Nautilus* are all dead, I am the last one. The machinist died of cancer only months after the spill. Then my fellow workers, tank cleaners, died of cancer, and one from natural causes. Then, in 1977 my supervisor and the machinist supervisor died only months apart from leukemia. After the spill of the four of us the supervisor went to see what caused the spill. They must have gotten really belted. When I say this, Mr. Chairman, is with radiation. I will elaborate a little bit more on that after. They might have gone into the area of the high radiation in some of the areas you could not work over 15 minutes. We had all kinds of lead shielding to work safe. Mr. Chairman, I am here today and asking the committee to have an investigation done by a private group—not the Navy or any other Government agency.

Mr. Chairman, I am concerned and others are also. I could go on and on about the high exposure that fellow workers got during the overhaul of the *Nautilus* that no one wanted. In my opinion it was rotten with radiation exposure.

Mr. Chairman, I would be glad to answer any questions. I do have documents, if necessary. I also want to thank Senator McIntyre, Senator Durkin, Congressman D'Amours, Senator Hathaway and Dr. Najarian for the alert to the workers at Portsmouth Naval Shipyard.

Mr. Chairman, I have documented material, as you see, you heard Captain McDonough, I have the alert cards of 1963, which I am questioning that total of 4,781. I feel on the *Nautilus*, Mr. Chairman, the limits were very high. We could not work in an area probably 5 to 10 minutes. I do have other areas where you could probably 15 minutes in one area, or 10 minutes.

If you saw the records later on, you will see that a lot of people on the *Nautilus* really got belted with radiation.

Mr. ROGERS. Thank you. Let me ask you this, if I may, what would you do? You would work for 10 minutes, and then what?

Mr. BELHUMEUR. They would take you out. You probably heard that I said they gave you a waiver. I know of getting 500 mrem in one day, and about 2 hours later they would call Washington because the Navy was controlling the radiation at that time, in 1959. It was new, they had the reins. Naturally, we were all working on a barge, and most naturally they used to say, "OK, you can go down and get 500 more." I can have people that would testify on that, I have supervisors that would like to testify.

Mr. MARKEY. Can I ask a question, Mr. Chairman?

Mr. ROGERS. Certainly.

Mr. MARKEY. 500 more what? 4,781 what?

Mr. BELHUMEUR. You ask me, I don't know. 4.7 rem, I guess.

Mr. MARKEY. 4.7 rem's, all right.

Mr. BELHUMEUR. Mr. Chairman, I have also here my exposure, which I am questioning, one of the ones that died with leukemia on the count of the body count. I would like to have you people look at this.

Mr. Rogers. Certainly, we will be glad to.

Mr. Belhumeur. I feel that there is a discrepancy as far as whoever made them out.

Mr. Rogers. Let me ask you this, if I may. Could you give us the names of the men who were with you, who were sprayed; and those who died?

Mr. Belhumeur. The ones that were working with me were Lloyd Hayman——

Mr. Rogers. And what happened to Mr. Hayman?

Mr. Belhumeur. Mr. Hayman died from natural causes. Leslie Thompson, who died from cancer, he came from Kennebunkport, Maine, Mr. Hayman came from Scarborough, Maine; and myself and Mr. Grivois. Mr. Grivois was the machinist.

Mr. Rogers. And what has happened to Mr. Grivois.

Mr. Belhumeur. Mr. Grivois is the one that died very soon after the exposure. What he was is that he was machinist—I do not really know what his work was on that date, but he did get contaminated.

Mr. Rogers. Now, you said also a supervisor?

Mr. Belhumeur. Yes, my supervisor and Mr. Leocha.

Mr. Rogers. Do you remember the name of your supervisor?

Mr. Belhumeur. His name is Oliver Gerry.

Mr. Rogers. Oliver Gerry.

Mr. Belhumeur. Yes.

Mr. Rogers. And what happened to Mr. Gerry?

Mr. Belhumeur. Mr. Gerry also died with Mr. Leocha of leukemia within 3 weeks last year, 1977. After the accident, in 1959, most naturally two supervisors knew that we got contaminated, and they went down to check the area. This is how come we have six people that were involved. Five of them are dead, and I am the only one living. I am concerned, Mr. Chairman, of the low radiation exposure, and I would, as I said, like to have a private team to check it out.

Mr. Rogers. Thank you so much, and we plan to do exactly that. Your testimony will be most helpful, particularly with the names you have given.

Mr. Belhumeur. Mr. Chairman, as Captain McDonough said, we do have the training. As far as the training, I can say the training was there. I have another copy here of people, the ship's force and people from other shops that could go to work in these areas, only work 10 minutes; and I am going to give that to you.

Mr. Rogers. I think that would be helpful to have it for the record. Without objection, it will be made part of the record

[The information referred to may be found in the subcommittee files.]

Mr. Carter. Mr. Chairman?

Mr. Rogers. Dr. Carter.

Mr. Carter. Were there six men in your crew?

Mr. Belhumeur. Well, there were four and the two supervisors after the accident, they found out that we got contaminated. They went down, they got concerned about their employees. They did go down, and most naturally I do not know what area they went in. Most naturally, when I found out that Mr. Grivois had died I went to Mr. Leocha and I said, "Jim, why don't you go to bat, for Mr.

Grivois? You must know that he got belted because he had deep pores, and the system water went in his face," and I said, "Why don't you go to bat for the widow?"

And Jim said, "Well, what can I do?" So, Mr. Chairman, again, 3 weeks before Mr. Leocha died he called me down to the Moose—I am past governor of the lodge—and he said, "Bunny, I have leukemia." I said, "You know, your buddy just died 3 weeks ago"—that was Mr. Oliver Gerry." I said, "Jim, you are going to White River Junction, and I don't know what we can do, but I want to wish you good luck."

Then he started telling me about him going to check these areas with Mr. Gerry. I do have the autopsy report of Mr. Leocha of the Veterans' Administration in White River Junction, Vt., which I will give you a copy of.

Mr. **Carter**. How is your health, by the way?

Mr. **Belhumeur**. What is that?

Mr. **Carter**. How is your health?

Mr. **Belhumeur**. At this time fine, Mr. Chairman. As I said, I went out of the shipyard, retired in September of 1977. But I have been out of the shipyard since 1974 because the shipyard threw me out because I was saving management $100,000 in months and they said, "There is no more work for you." So, the only thing I had to do, as I said, I got hurt on the *Sam Rayburn* in 1971, in March. I had a fractured shoulder, I have a plastic shoulder. I had a concussion; I had five ruptured ribs, and this is all documented. I was out for 18 months. Then I went back in August 1972 to November 1974. And the production officer said, "There is no more work for you here," I went out.

Mr. **Carter**. Do you have regular checkups?

Mr. **Belhumeur**. Yes; I am under doctor's care, Dr. Betz and Dr. Stram for a lung problem. I just got out of the hospital New Year's Day, in fact; I was in for 17 days. I have a bad problem of breathing.

Mr. **Carter**. Bleeding?

Mr. **Rogers**. Breathing.

Mr. **Carter**. Breathing. Emphysema?

Mr. **Belhumeur**. Yes.

Mr. **Carter**. All right, thank you.

Mr. **Rogers**. Any questions, Mr. Markey?

Mr. **Markey**. Are you aware of any other accidents on the *Nautilus*, or during your tenure in the shipyard, which were not reported?

Mr. **Belhumeur**. Mr. Markey, if I went and said all these little accidents that happened, we would be here all day. As you know, the *Nautilus* was the first one. And when it first came into Portsmouth it cost a lot of money—the Navy spent a lot of money. In fact, I do not think the Navy wanted it sent to Portsmouth. And records show that it did cost Portsmouth a lot of money.

Mr. **Markey**. So, you are saying that there have been a lot of other accidents in addition to the *Nautilus*, that have not come to public light?

Mr. **Belhumeur**. That is right. In fact, the record will show—and I know you people can get this—there was sabotage, suspicion of sabotage on board the *Nautilus*. I do not know if you people remember this, or not. This was all investigated by the Navy themselves. So, none of that went out because it was one of their people, Navy personnel, that did it.

Mr. ROGERS. May I ask, was your accident reported to the people in charge; how was it handled?

Mr. BELHUMEUR. Once we got contaminated, most naturally you have radiological people. They took us in a truck and took us down to a building which they called 233.

Mr. ROGERS. Did they make a report?

Mr. BELHUMEUR. That is something I do not know, I really do not know because they are running the show.

Mr. ROGERS. So, you do not know whether it was actually reported, although you were taken for treatment.

Mr. BELHUMEUR. As far as the records being kept, the Navy kept the records aboard the *Nautilus.*

Mr. ROGERS. On you?

Mr. BELHUMEUR. I am talking about anything that happened.

Mr. ROGERS. I see.

Mr. BELHUMEUR. In fact, I had supervisors that would not even go down. In fact, I acted as supervisor for the cleaning group because you could not even go down and work 5 minutes because we had supervisors that would not even go down. If the committee really wants these people's names—in fact one of them is dead, Mr. Marlakey died of cancer, also, which was a supervisor—but Mr. Freeman Linscott would be very glad to give his views.

Mr. ROGERS. Could you give us his address?

Mr. BELHUMEUR. Yes; I will. His address is North Berwick, Maine.

Mr. ROGERS. That would be helpful. I think any information in that area would be helpful. Excuse me, Mr. Markey.

Mr. MARKEY. Thank you, Mr. Chairman.

Those other accidents which you talked about, which have gone unreported, why have they gone unreported?

Mr. BELHUMEUR. That is something I could not tell you.

Mr. MARKEY. Well, is there sort of a silent conspiracy not only among the supervisors, but also among the employees, that it is known if they do report these things, that would jeopardize their job; they would put themselves in some kind of position where reprisals could be taken against them?

Mr. BELHUMEUR. Well, I have here, but I do have a code of ethics that the shipyard puts out, about giving out any information pertaining to anything like this. I will look for it in my briefcase, and I will leave it for you people. If you gave out any information at that time, you might have been looking in, or looking out because I think it was vital, and I guess they did not want to upset the applecart.

Back to the radiation exposure, when they gave you, we will say, 500 millirem, and they went to call—I do not know who they went to call in Washington, they would make a phone call to somebody and say, "OK, can certain people have more radiation exposure—OK".

Mr. MARKEY. So, you are saying that waivers were given indiscriminately to those that wished to have them? What time period are you talking about right now?

Mr. BELHUMEUR. I am talking about 1959.

Mr. MARKEY. What about since 1963?

Mr. BELHUMEUR. In 1963, Mr. Markey, they started giving out alerts card's they brought the levels down lower; and they were looking—looking out for the health of the people.

On the *Nautilus,* I know, that was the first one, and other submarines that did come in to the shipyard after that, it was really in good shape. I mean, there were not as many accidents as way back then.

Mr. MARKEY. So, you are saying between the 1959 and 1963 time period that waivers were given almost indiscriminately, but since 1963 there has been a tightening.

Mr. BELHUMEUR. That is right.

Mr. MARKEY. Let me ask one final question. Were you ever made aware of the lifetime limit that you could and should have been exposed to?

Mr. BELHUMEUR. Mr. Markey, the only time that I really knew was September 22, 1977, what my lifetime exposure was.

Mr. MARKEY. That was the day that you were terminated.

Mr. BELHUMEUR. Right.

Mr. MARKEY. Should you have been made aware of the limit?

Mr. BELHUMEUR. I agree. Also, Mr. Markey, I had been off radiation since 1971.

Mr. MARKEY. Even during the time that you were working in radiation, you were not made aware of it.

Mr. BELHUMEUR. Right.

Mr. MARKEY. How about your fellow workers, were they made aware of it?

Mr. BELHUMEUR. Well, since then, yes, they have boards in the shop where every one of them by day has their exposure. So, everybody knows how much exposure they have.

Mr. MARKEY. To your knowledge, in the period, let us say, before 1971, individual workers inside the nuclear portions of the plant had no knowledge of what they should have been exposed to in a lifetime, in order to preclude the possibility of them contracting some type of——

Mr. BELHUMEUR. The total, yes. Except, I knew that they were keeping close tabs, like Captain McDonough said, they do have people that did come close to the total, then they would pull these people out. We know of that.

Mr. MARKEY. The individual did not know, but his supervisor was aware of it.

Mr. BELHUMEUR. Whoever the radiological people were that were handling the total dosage, yes.

Mr. MARKEY. An individual person was not trusted with the knowledge himself on what danger he was placing himself in; only his supervisor would be able to make the determination for him?

Mr. BELHUMEUR. To go back, Mr. Markey, in 1959, up to 1963, I said the dosimeters were no good. The film badge, I do not know, the stuff it was made out of paper and I do not think that really it would show the real amount because any sweat on the film badge, you know, what I mean, The film itself—I do not know who they could develop it. This is why I question my exposure of 2/63 of 4781. I feel that I did have more because I have known many times when I went down in the *Nautilus* and got 500 millirems in 1 day. And then, 3 days after, get another 500. And if a boat is in there for a period of 18 months for an overhaul, you are going to get a lot of radiation.

Mr. MARKEY. Was that in the 1959 to 1963 period, or subsequent to that?

Mr. BELHUMEUR. Right, I would say 1959-60.

Mr. MARKEY. 1959-60? When you did have the accident which required you to be taken to the decontamination unit? Did the doctors check your urine or fecal samples to determine the amount of radiation that was taken internally into your system?

Mr. BELHUMEUR. No.

Mr. MARKEY. They did not.

Mr. BELHUMEUR. The only time that I took a body count was in November 1972, and this is why I would like to have the committee compare by body count with Mr. Leocho's body count, and you will see the discrepancies.

Mr. MARKEY. The internal potential damage was never measured.

Mr. BELHUMEUR. Right.

Mr. MARKEY. No more questions, Mr. Chairman.

Mr. ROGERS. Mr. Walgren?

Mr. WALGREN. I have no questions, thank you.

Mr. ROGERS. Thank you so much for your help to the committee, and we will be in touch on specific records.

Next we have Dr. William Foege, who is Director of the Center for Disease Control, and Dr. J. Donald Millar, Acting Director, National Institute for Occupational Safety and Health.

We welcome you back to the committee. Your statement will be made a part of the record, and you may proceed as you desire.

Dr. FOEGE. With your permission, I would also like to ask Dr. Craft from NIOSH to join us, in order to help answer questions.

Mr. ROGERS. Certainly. Dr. Craft, we welcome you to the committee.

STATEMENT OF WILLIAM H. FOEGE, M.D., DIRECTOR, CENTER FOR DISEASE CONTROL, PUBLIC HEALTH SERVICE, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, ACCOMPANIED BY J. DONALD MILLAR, M.D., ACTING DIRECTOR, NATIONAL INSTITUTE FOR OCCUPATIONAL HEALTH AND SAFETY; AND BOBBY F. CRAFT, DIRECTOR, DIVISION OF SURVEILLANCE, HAZARD EVALUATION AND FIELD STUDIES

Dr. FOEGE. In response to Senator's McIntyre's request, which has previously been mentioned, Secretary Califano directed our agency to immediately contact the Navy, review what information is available and determine what type of study would be needed.

With his request, Senator McIntyre enclosed the article from the February 19, 1978, Boston Globe. Subsequently, yesterday, we had the opportunity to review the study reported in the Boston Globe that was conducted by Dr. Najarian and Dr. Colton.

It is becoming increasingly apparent that there is a need for further study of the possible association between apparently low-level exposure to nuclear radiation and increased incidence of certain diseases, including leukemia and other cancers. Last month I testified before this committee about our investigation of cases of cancer and leukemia among persons present on August 31, 1957, at the nuclear test in Nevada code-named Smokey. We now have a report of similar illnesses reported among employees at shipyards, working with nuclear submarines.

This Department, HEW, has interest in helping to determine if these illnesses are in fact associated with radiation exposure.

The study by Drs. Najarian and Colton was based upon evaluation of the death certificates of 1,722 former shipyard workers and interviews with next of kin of 592 workers to determine if they had been exposed to radiation. We feel on the basis of our preliminary examination that this study was well done. it does have certain limitations, but these have been recognized and acknowledge by the authors. A definitive study would require a complete followup of the total group of shipyard workers and better information on the exposure history as well as the medical history of workers who have become ill or have died. It would be necessary to examine the evidence carefully that indicates whether these workers had experienced potentially hazardous exposures from neutrons or internal doses from alpha or beta radiation contamination.

It is important to recognize that 15 to 20 years ago the environmental and medical monitoring procedures and instrumentation were relatively unsophisticated. For instance, film badge monitoring of employee was, at best, an indication of possible radiation exposure and may not have been an accurate indicator of total body exposure.

In addition to reviewing radiation monitoring records, it would also be important to examine the work histories and personnel and medical records of these employees. The smoking histories of the workers are also important since there is a known synergistic effect between radiation exposure, smoking and the incidence of lung cancer. It should be determined whether these workers were also exposed to other hazardous agents, known to produce similar effects such as asbestos and benzene. A thorough study would also investigate the reproductive history of workers exposed to radiation.

Mr. ROGERS. Well, let us stop here. Mr. Miles, there is no problem with getting that information, I presume.

Mr. MILES. I do not know about the industrial hygiene data.

Mr. ROGERS. Well, I mean, if you have it, it would be available; would it not?

Mr. MILES. I think it would be.

Mr. ROGERS. Well, I want to know. You cannot tell us whether that would be available, or not?

Captain RIVERA. That would be available, yes, sir.

Mr. ROGERS. All right. Thank you. You may proceed.

Dr. FOEGE. We would also need health information on personnel, including outcome measurements, such as, did they have illness, did they die, what was the cause of death. We would require environmental monitoring records, and we would attempt to get reproductive histories of employees.

CDC is prepared to send a team of physicians and industrial hygienists to the shipyard to conduct an initial review of records and determine what further studies could and should be undertaken.

Mr. ROGERS. Just a minute. Now, you have heard what would be needed. Is there any problem that the Navy sees with furnishing this information, if you have it?

Mr. MILES. No, sir.

Mr. ROGERS. Thank you, sir.

Dr. FOEGE. On February 24 I wrote to the Secretary of the Navy and the Secretary of the Department of Energy, requesting access to the personnel and medical records of the past and present Portsmouth shipyard employees and assistance of their staff in identifying and reviewing the appropriate information and records. On the same date, the Secretary of the Navy informed Secretary Califano that the Navy has been negotiating with the Department of Energy to arrange for an independent study of the Portsmouth workers. Secretary Claytor said that he would provide CDC with the same records as are provided to the agency selected by the Department of Energy to conduct their study. He also expressed concern about possible duplication of effort.

We would share the Secretary of the Navy's concern that a coordinated effort be made to investigate the possible effects of radiation exposure among the shipyard workers. We believe that the following conditions should govern further studies. (1) The studies must be objective, sound, and scientifically independent; (2) if needed, broader followup studies must be conducted with highest priority and with adequate funding guaranteed at the beginning; (3) the scientific protocols, prior to implementation, should reflect a consensus of the best scientific judgment of the agencies involved; (4) independent and continuous scientific oversight of the studies should be conducted as they progress; and (5) the final interpretation of the results should be based on an objective and comprehensive analysis of the data.

In summary, we believe the study by Dr. Najarian already provides ample reason for a detailed evaluation of health and exposure history of workers at Portsmouth.

No. 2, as you have heard, the Secretary of the Navy agreed to provide us with records, and it appears now that this agreement does extend to access to records that would make this a high-quality study.

We are prepared to send a team immediately to begin work on this project, and we will recontact the Navy following the hearings, to determine if we have such clearance.

Mr. Chairman, we will be happy to answer any questions either you or members of the subcommittee might have.

Mr. ROGERS. In other words, you still have not been cleared?

Dr. FOEGE. I think from what we have heard today, that we do have clearance. We will get with the Department of the Navy immediately following the hearings to see if there are other steps that have to be taken.

Mr. ROGERS. Well, let us find that out. Mr. Miles, is there any problem?

Mr. MILES. Mr. Chairman, I am not in charge of the Nation's shipyards. You missed the people that could answer that one. I do not know of any problem; I do not see why there should be any problem. The Secretary of the Navy has written back saying OK.

Captain RIVERA. Have you received a letter requesting a point of contact? There was a letter that went out on Friday requesting a point of contact with your office.

Dr. FOEGE. Yes; we have given this point of contact to the Department of Defense.

Mr. ROGERS. All right; will you advise the committee if there is any difficulty?

Dr. FOEGE. We will.

Mr. ROGERS. Also, I think it is clear that the implied restriction in the Secretary of the Navy's letter does not apply. In other words, they have already stated they would cooperate fully and give all the information that they have, that you ask for. That has been confirmed in the hearing. If there is difficulty, the committee would want to know.

Dr. Carter?

Mr. CARTER. Thank you, Mr. Chairman. I am interested in a statement on page 2 of your presentation:

> It is important to recognize that 15 or 20 years ago the environmental and medical monitoring procedures and instrumentation were relatively unsophisticated. For instance, film-badge monitoring of employees was, at best, an indication of possible radiation exposure, and may not have been an accurate indicator of total body exposure.

That is 15 or 20 years from the present day. Of course, at the atomic blast Smoky, which occurred August 31, 1957, the film badges did not accurately record exposure to radiation; is that correct?

Dr. FOEGE. The film badges did not measure total body radiation; that is right.

Mr. CARTER. So those men may have received much more than was actually registered on the badges. At the same time they might have received less. Many of them, at Smoky, for instance, did not get total body counts, either.

Now, if CDC were to take over the study of the Portsmouth shipyard workers, what resources would you need?

Dr. FOEGE. We believe, Dr. Carter, that a study such as this depends on how good the records are. Our experience, when we go into industrial settings, is that it does require a fair amount of work to reconstruct the records. And to do a cohort study on approximately 20,000 people could well take 2 or 3 years and require some place between $750,000 and $1 million to complete. Earlier, and I would like to correct this for the record, the statement was made that it would take 2 or 3 months. I think what was intended by that statement was, in 2 or 3 months we would know what records were available, and how complete the study could be. But actually following 20,000 men would require 2 to 3 years.

Mr. CARTER. Yes, sir. Would NIOSH be better able to undertake this task than CDC?

Dr. FOEGE. NIOSH is a part of CDC, and NIOSH would have the lead in this because they have the physicists, they have the industrial hygienists; and they would be using epidemiologists from the remainder of CDC as required. I think the main point here is that they are well acquainted with health hazard evaluations. They do over 100 a year in industrial settings; and throughout CDC we do many cohort studies. That is really the expertise that is required, the ability to do a cohort study.

Mr. CARTER. Do you anticipate any problems with access to medical records because of the Privacy Act?

Dr. FOEGE. From what we have heard today, I would not expect problems with access to records.

Mr. CARTER. How can the subcommittee here be helpful?

Dr. FOEGE. I think that we would like an opportunity to report back at intervals to the subcommittee on how these studies are progressing.

Mr. CARTER. Yes, sir. Could you review briefly the epidemilological expertise of your CDC staff, and those of NIOSH, who you expect would work on this study?

Dr. FOEGE. Yes. We would expect to use epidemiologists who are acquainted with health hazard evaluations, and we do over 100 of these major evaluations per year, as well as epidemiologists who work on other epidemiologic problems, and we do over 1,700 such investigations a year. They would be assisted by industrial hygienists who would look at what is actually happening, what kind of exposures are people having. And they would be assisted by physicists and others who would help with the technical data.

Mr. CARTER. Thank you very kindly, Dr. Foege.

Mr. ROGERS. Mr. Markey?

Mr. MARKEY. Just one question, Mr. Chairman.

The Navy indicated that the Department of Energy study would take 8 years to finish. How long do you think it will take?

Dr. FOEGE. It really depends on how good the records are and how accessible they are. We are basing our experience on what happens in industrial settings. We would expect that the Navy records would be as good or better. So, our 2- to 3-year estimate is based on industrial experience.

Mr. MARKEY. Do you think it would be possible, as Dr. Rosen indicated, that you will be able to give us some kind of advance notice, an update, maybe, within a 2- or 3-month period after you have made an analysis, or a random sample of about 1,000 of these people. Would you be able to get back to us with some kind of indication, so that we would be able to set public policy and head in a direction that would insure the public safety?

Dr. FOEGE. I think we could very easily, within 2 to 3 months, give you a statement on what is possible.

Mr. MARKEY. Thank you.

Mr. ROGERS. As I understand it, then, after looking at the Najarian and the Colton study and their conclusions, you feel they are sound as far as they go?

Dr. FOEGE. That is right. As they point out in their paper, they are doing a proportional mortality study, which is really looking only at the numerators; it is looking at people that have died. It is not getting death rates. But as far as it has gone it is a good study.

They also were not able to get exposures for people, and also, they were not able to indicate the different kinds of leukemias they were seeing. But they recognized this in the paper, and we think it is a good study as far as it goes.

Mr. **Rogers.** So that the 2 to 1, a rather startling figure, certainly warrants speedily proceeding with an adequate and broad-based study.

Dr. **Foege.** We think it does, yes.

Mr. **Rogers.** Thank you so much, we are grateful to you for being here.

Mr. **Carter.** Just one other question.

Mr. **Rogers.** I am sorry, Dr. Carter has a question.

Mr. **Carter.** You said you had a chance to review this study, and I believe you stated that there is no differentiation of the types of leukemias; is that correct?

Dr. **Foege.** That is right. Since they obtained this information from death certificates they have not been able to go back and look at the kinds of leukemias.

Mr. **Carter.** Of what help would that be to you?

Dr. **Foege.** Well, we know that chronic lymphocytic leukemia has not been indicated in the past with radiation, and we would want to know how many of these cases were chronic lymphocytic leukemia.

Mr. **Carter.** But that does not rule out the possibility that chronic lymphocytic leukemia could be caused by radiation.

Dr. **Foege.** That is right, and we would still have to explain why the increase.

Mr. **Carter.** On the other hand, lymphoma has been associated with it; has it not?

Dr. **Foege.** That is correct.

Mr. **Rogers.** I think Dr. Najarian said only one such case.

Dr. **Najarian.** We did not specify in the paper what types of leukemias, but there was only one chronic lymphocytic in the nuclear group.

Mr. **Rogers.** Only one. Thank you for your presence here today, we appreciate it. And the committee will be expecting you to keep us advised as you proceed.

Dr. **Foege.** Thank you very much.

Mr. **Rogers.** Thank you.

The last witness will be Dr. James Liverman, the Acting Assistant Secretary for Environment, U.S. Department of Energy, accompanied by Dr. Walter Weyzen, Division of Biological Environmental Research, Manager of the human health studies program of the Nevada Operations Office, and Dr. W. R. Albers, who is the Medical Director of DOE.

We welcome you back to the committee, Dr. Liverman. We will be pleased to receive your statement and it will be made a part of the record in full. You may proceed.

FURTHER STATEMENT OF JAMES L. LIVERMAN, PH. D., ACTING ASSISTANT SECRETARY FOR ENVIRONMENT, DEPARTMENT OF ENERGY, ACCOMPANIED BY WALTER WEYZEN, M.D., M. PH., DIVISION OF BIOLOGICAL ENVIRONMENTAL RESEARCH, MANAGER, HUMAN HEALTH STUDIES PROGRAM, NEVADA OPERATIONS OFFICE; AND W. R. ALBERS, M.D., CHIEF OCCUPATIONAL MEDICINE BRANCH, DIVISION AND ENVIRONMENTAL SAFETY

Dr. LIVERMAN. Thank you, sir, I will try to make it as rapid as possible to cut off your long day.

Mr. Chairman, as a result of my discussions with this subcommittee at a hearing earlier this month and, particularly, your request that I look, carefully, into the matter of low-level occupational exposures, I have reexamined the health and mortality program, the need for additional studies of populations present at past weapons tests, and the more recent concern for health of workers at naval shipyards involved in the nuclear propulsion program, which is the specific subject under discussion today.

There are four areas in which I am prepared to take immediate action. One of these is to expand the Department of Energy health and mortality study to all DOE facilities. Previously it has been limited to the Hanford, Oak Ridge and Mound Laboratory sites.

The second is the establishment of a medical followup program for former employees exposed to 5 rem or more in any 1-year period. We do that for our current employees continuously.

The third is initiation of studies of persons exposed at weapons tests relating to Desert Rock, jointly with the Department of Defense and the Veterans' Administration, and to be conducted by the National Academy of Sciences and closely coordinated with the Center for Disease Control. I think you are aware of those studies already.

The fourth is the initiation of studies of workers in the nuclear propulsion program at naval shipyards, beginning with the worker population at the Portsmouth Shipyard and of communities surrounding the facilities. Admiral Rickover testified on this subject earlier today.

The present Department of Energy "Health and Mortality Study" is centered at Oak Ridge Associated Universities and the Hanford Environmental Health Foundation and focuses on present and past worker populations at the Hanford plant, Washington, the Oak Ridge facilities, Tennessee, and the Mound Laboratory, Ohio. Recent results of an epidemiological study of Hanford workers occupationally exposed to low levels of radiation appear to demonstrate adverse effects on the health of workers. The number of workers studied, thus far, is only a relatively small sample of all workers exposed between the mid-1940's and now. These results, if accepted at face value, raise serious concern about the adequacy of occupational exposure standards. Uncertainties of the validity of the findings do not permit an assessment of potential health problems in radiation workers.

In fiscal 1978, $650,000 is budgeted for the health and mortality study. Expanding and accelerating current efforts to obtain earlier analysis of Hanford and Oak Ridge data which cost an estimated additional $200,000 in fiscal year 1978 that will have to be reprogramed from other areas to support this acceleration. We also are looking at the probable redirection of funds in fiscal 1979 to continue this effort. Additionally, the study would now extend to all DOE facilities—approximately 40 additional ones—at an estimated cost of approximately $200,000 for initial planning and record collection this year, with a much larger expansion next year.

Second, uncertainties in the quality of the information on the effects of radiation exposures at upper levels of current occupational guidelines do not pemit an accurate assessment of morbidity or mortality of these populations. At present, only individuals receiving a whole-body dose of 25 rem or 600 rem to an extremity—are entered into the registry at Oak Ridge Associated Universities and followed by a medical questionnaire, with physical examinations if indicated or requested. Under the proposal for a medical followup program, medical questionnaires and elective physical exams would be made available to any individual who receives more than 5 rem in any 1 year. It is estimated that the number of individuals in this group would be fewer than 3,000 people. In fiscal 1978, we have about $75,000 allocated for the registry. The expanded medical followup program would cost an estimated $150,000 in 1978, and possibly additional funds in fiscal 1979. These amounts can be reprogramed within our current resources.

Third, currently available information regarding the persons exposed during the weapons test program does not permit any firm conclusion with regard to the incidence of leukemia in Smoky participants, but is highly suggestive. Two areas need to be addressed: Is the incidence of leukemia in personnel connected with Smoky increased? This information is expected to be derived from the study now ongoing at the Center for Disease Control. Are these findings for people present at Smoky unique, or are we to expect similar findings among participants of other events at the Nevada Test Site or the Pacific operations? The findings for Smoky, if taken at face value, raise serious concern with regard to the health of participants of the Department of Energy and of AEC contractors in the weapons testing, in addition to those in the military.

To determine as rapidly as possible if any adverse health consequences result from participation at weapons tests, a study of military participants will provide an early indication of adverse health effects. DOE plans to join the Department of Defense and the Veterans' Administration in support of studies to be conducted by the followup agency of the National Academy of Sciences. The Department of Defense has requested a study protocol from the National Academy of Sciences. It is estimated that our cost in fiscal 1978 will be $150,000. This study will be conducted in parallel and in close coordination with the Center for Disease Control.

The final planned program is in the area of today's hearings. Since you have asked, particularly, about the health and mortality study of workers in the naval shipyards reactor programs, I will go into some more detail on the plans and include a discussion of the events which led to the Department of Energy and naval reactors program discussion. You have asked for copies of the correspondence between the two agencies, and I would like to submit these for the record at this time, Mr. Chairman.

Mr. ROGERS. What is that, please?

Dr. LIVERMAN. You had requested of us copies of internal memos, as well as correspondence. This package is complete except for one memo which we will provide.

Mr. ROGERS. That will be fine, thank you.

Dr. LIVERMAN. On December 13, 1977, as we have heard already, officials of the Office of Environment met with Division of Naval Reactors personnel at that Division's request. The attendees were Mr. Miles, and Mr. Kindley, Division of Naval Reactors; Dr. Walter Weyzen, who is on my right here, manager of the human health studies program of the Division of Biomedical and Environmental Research; and on my left, Dr. Albers, who is the Chief, Occupational Medicine Branch, Division of Operational and Environmental Safety; and Dr. Clifford Patrick, leader of the demographic program at the Oak Ridge National Laboratory.

The principal purpose of the meeting was to discuss current information on the effects of low-level radiation. In the course of the discussion, Mr. Miles identified two public concerns regarding nuclear shipyards—that there appears to be an increased disease incidence in populations that live around the nuclear installations, and that working in the shipyard could be associated with increased morbidity or mortality. My staff advised Mr. Miles that such claims can only be answered by collecting morbidity and mortality information on these populations and thoroughly evaluate it.

As a result of that meeting, Dr. Weyzen requested the Oak Ridge National Laboratory to undertake the responsibility for initiating a systematic collection of demographic information on populations living around the shipyards involved in the nuclear propulsion program—not the workers themselves, but the people in the communities surrounding them. The data collection and analysis are in progress; however, it is too early in the evaluation to reach even preliminary conclusions concerning the general health of populations living in the vicinity of these shipyards. It was also decided that a review of a representative shipyard should be made, and that the personnel record system would be inspected to assess the potential for an epidemiological study of the morbidity and mortality of the nuclear propulsion program workers.

On December 30, a letter from Admiral Rickover to me affirmed the request for assistance in conducting a study of naval reactor shipyard employees. He provided the names of six shipyards used in the nuclear propulsion program and recommended the Charleston Naval Shipyard for the initial review.

At the direction of Dr. Weyzen, the initial inspection of the Charleston Naval Shipyard was conducted on February 14 by personnel from Oak Ridge Associated Universities, and the Hanford Environmental Health Foundation. A significant portion of the "walk-through" consisted of a review of the naval radiological health programs in general. Written reports on the findings and results are in preparation; however, discussions with the reviewers indicate the encouraging preliminary opinion that the work force data are adequate, and a meaningful study will be possible.

On February 16, 1978, Dr. Weyzen met with Mr. Miles of the naval reactors program to discuss the Charleston review. It was agreed that the Office of Environment would conduct an epidemiological study of the naval shipyards, and Mr. Miles identified the Portsmouth Naval Shipyard as the preferred initial site.

On February 23, 1978, Dr. Weyzen and Mr. Miles met with Dr. R. Seltser and Dr. Matanoski, School of Hygiene, Johns Hopkins University, to obtain their advice on the initiation and design of an epidemiological study of the workers in the nuclear propulsion program at the Portsmouth Naval Shipyard. Since then, we have received a positive indication from the Johns Hopkins University that they are interested in such a study and will submit an informal proposal for the conduct of a more thorough feasibility study. A walkthrough of the Portsmouth Naval Shipyard has been scheduled in March, and the feasibility study will be initiated shortly thereafter.

In the meantime—on the advice of Drs. Weyzen and Matanoski—personnel at the Portsmouth Naval Shipyard are beginning to assemble work force information. First, they are constructing a roster of all personnel separated from the shipyard since 1959, the year that the nuclear propulsion program was initiated. Such a roster is essential to identify the deceased and determine their cause of death.

For the nuclear propulsion program at naval shipyards, the Department of Energy will be conducting two separate studies. One will be an evaluation by the Oak Ridge National Laboratory of the population living near all of the six shipyards. The second study will be an evaluation of the work force of the shipyard to be conducted by university-based researchers as a separate and independent study. The work force evaluation is just beginning, with Portsmouth being the initial site. The estimated cost of the Portsmouth study is $150,000 annually. Drs. Weyzen and Albers are both with me today if you wish to have more details concerning the naval reactors program study.

Mr. Chairman, I would like to add one additional point or two about discussions that I had today with Dr. Handler, President of the National Academy of Sciences. I have requested that he put together, as rapidly as possible, a committee to look at all of the low-level radiation studies which are going on in my programs.

He discussed with me the possibility of using the BEIR Committee (Biological Effects of Ionizing Radiation). Dr. Ted Radford, as you know, testified about the committee's study the other day. We looked at the list of people on the committee and felt that the group might have to be enlarged a little bit to include more epidemiological expertise. Perhaps that will be the committee that he will use to review the DOE program in the effects of low-level radiation.

In addition, I called the president of the board of the Oak Ridge Associated Universities—which is under the auspices of 45 universities in the Southeast—and had a long discussion with him about the need to expand the size of his overview committee in the biomedical area to observe as closely as possible those studies that are going on in the Oak Ridge Associated Universities, and the ones at Hanford, being carried out by the Hanford Environmental Health Foundation.

He assured me that he felt the idea was a very important one, and that he would take up with the board at their next meeting, the addition of a number of people with epidemiological, medical, and statistical expertise to that overview committee. This advisory committee reports directly to the board. He will be back to me to discuss the judgments of the board on that; but he could see no reason why that should not be done.

One additional point, and then I will finish my statement. About 4 years ago I came up with the thought—and I now regret that I did not at that time insist on carrying it out—of looking at populations around each of our sites and pulling together the health statistics from the Bureau of Health Statistics; the demographic information; the business and economic information and take a look and ask the question: Is there any reason to suspect that the presence of our sites has led to any kind of an increase in the incidence of disease of any particular type? And if there is an increase, take steps to determine if there is any relation between that and radiation.

Those studies will be expanded in the very near future to allow us, then, to look not only at our employees, to see if there is any indication of any kind which should lead us to believe that the presence of our plants—and particularly the radiation aspects of it—have contributed in any way to any increased incidence of disease.

Thank you, Mr. Chairman, for the opportunity to present this statement.

Mr. ROGERS. Thank you, Dr. Liverman. I think the committee is pleased to see you expanding the health and mortality study to all of the DOE facilities. There are some 40 such facilities?

Dr. LIVERMAN. Yes, in addition to Hanford and Oak Ridge.

Mr. ROGERS. And this establishment of a medical followup program for individuals exposed to 5 rem or more, and the initiation of studies through the National Academy of Sciences in cooperation with the other departments. And then, the initiation of studies of workers in nuclear propulsion.

Now, you say the people that will do that are at Johns Hopkins?

Dr. LIVERMAN. We have not made a decision about that. I think Dr. Weyzen could address that question. We have had discussions with them. They have an outstanding department of epidemiology. When we get their proposal we will have a much better idea.

Mr. ROGERS. Let me just ask a question or two, and then I will conclude and come back later.

You met first with Mr. Miles on the Portsmouth matter?

Dr. WEYZEN. No, sir. The first meeting on December 13, 1977, did not concern the Portsmouth matter.

Mr. ROGERS. And what did he indicate to you? He said there appeared to be an increased incidence of disease in populations that live around the nuclear installations?

Dr. WEYZEN. There are two parts to it, sir. One was his concern about workers and the findings in the final report of the University of Pittsburgh by Dr. Mancuso. And the second part referred to the fact that the community—as indicated by telephone calls or whatever—was concerned that either living around naval shipyard facilities or working at naval shipyard facilities was unhealthy.

Mr. ROGERS. How did he say that had been determined, this concern about living around the installation. How had that been exhibited to him?

Dr. WEYZEN. I presume by inquiries that came from people outside to the shipyards.

Mr. ROGERS. Did he say anything, had they made a study of it?

Dr. WEYZEN. Not that I know of, sir.

Mr. ROGERS. Had he been advised by the shipyard commanders, or what did he say?

Dr. WEYZEN. I do not think he said that. I do not recall.

Mr. ROGERS. Did you make any memoranda of your meeting?

Dr. WEYZEN. Yes, sir, there is a memorandum that is in the hands of the committee.

Mr. ROGERS. Did you give a copy of that to Mr. Miles?

Dr. WEYZEN. Yes, sir.

Mr. ROGERS. Have you had any other correspondence, or exchange of memoranda with Mr. Miles?

Dr. WEYZEN. Yes, sir; that is all in your hands.

Mr. ROGERS. You met with him two times since the first meeting?

Dr. WEYZEN. Yes, sir, at least two times.

Mr. ROGERS. Any other times?

Dr. WEYZEN. I would have to consult my notebook, sir.

Mr. ROGERS. Would you do that and let us know?

Dr. WEYZEN. Yes, sir.

Mr. ROGERS. Did you draw up any memoranda of any of those meetings?

Dr. WEYZEN. No, sir, these would be notes in my notebook.

Mr. ROGERS. Just notes?

Dr. WEYZEN. All memos that were written in this connection are in the hands of the committee.

Mr. ROGERS. Were any furnished to Mr. Miles?

Dr. WEYZEN. Yes, sir.

Mr. ROGERS. Copies were given to Mr. Miles?

Dr. WEYZEN. Yes, sir.

Mr. ROGERS. You agreed that the Department of Energy would pay for the study?

Dr. WEYZEN. Yes, sir.

Mr. ROGERS. Is that normal?

Dr. WEYZEN. I did contact Dr. Liverman and informed him of the fact that I had committed him to this funding.

Mr. ROGERS. Is that a judgment that you usually reserve, Dr. Liverman, or not?

Dr. LIVERMAN. May I explain to the committee that within the agency, the Assistant Secretary for Environment, and before that ERDA, has responsibility for supporting all technology groups. You heard the discussion of whether the admiral is Navy or DOE. The naval reactors program is clearly a program of the Department of Energy, and, as such, the Assistant Secretary for Environment assists the Assistant Secretary for Energy Technology, in whatever ways are requested. This is, clearly, one of those things.

The answer to your question is yes. It is the normal procedure for us to take on this responsibility. As to the question of total funding, that is an issue that will be resolved as the program continues. Clearly, they are going to pay for putting their records in shape.

We would, clearly, I believe, support a university to do the analysis that needs to be done.

Mr. ROGERS. Did you discuss with Mr. Miles who might do the study?

Dr. WEYZEN. Yes, sir, we discussed the possibility of several different universities.

Mr. ROGERS. Whom did you discuss with him?

Dr. WEYZEN. Harvard School of Public Health and Johns Hopkins University.

Mr. ROGERS. Johns Hopkins?

Dr. WEYZEN. Johns Hopkins, yes.

Mr. ROGERS. Not Oak Ridge Associated Universities.

Dr. WEYZEN. No, sir.

Mr. ROGERS. Nor the Hanford Environmental Health Foundation.

Dr. WEYZEN. No, sir.

Mr. ROGERS. You simply used them for preliminary surveys?

Dr. WEYZEN. That is correct.

Mr. ROGERS. Has the Hanford Environmental Health Foundation done similar surveys before?

Dr. WEYZEN. Yes, sir, that is their daily job.

Mr. ROGERS. Where?

Dr. WEYZEN. At the Hanford plant. The Hanford Environmental Health Foundation is responsible for the industrial hygiene and occupational medicine in the large plant.

Mr. ROGERS. Yes. Have they done surveys before?

Dr. WEYZEN. I have used Dr. Breitenstein and Dr. Reinert on surveys before.

Mr. ROGERS. Would you give us a record as to when they were used, and what amounts of money were paid for those?

Dr. WEYZEN. Yes, sir. Sir, there is no money paid for this.

[The following information was received for the record:]

Dr. Breitenstein visited Lawrence Livermore Laboratory in December 1977 to conduct an evaluation of the health and safety risks at the Laboratory. Dr. Breitenstein also served as a consultant in such matters as treatment of internal depositions of radionuclides and to review the adequacy of emergency medical care in industrial radiation accidents. In addition, Dr. Breitenstein is scheduled to participate in a proposed walk-through of a gasification plant in Yugoslavia in the very near future.

Mr. ROGERS. They are working for you?

Dr. WEYZEN. We asked them to do it, and the cost for such a survey comes out of the laboratory budget. We do not provide extra money for that.

Mr. ROGERS. They do any surveys you ask them?

Dr. WEYZEN. If I need advice on industrial hygiene or industrial medicine, for instance, I can ask him or anybody else to do that for me, yes.

Mr. ROGERS. Well, are they on your payroll, the Hanford Environmental Health Foundation?

Dr. LIVERMAN. Let me explain again. The Hanford Environmental Health Foundation is a not-for-profit organization chartered in Richland, Wash. Since July 1965, it has been contracted by the

Federal Government to perform industrial medical services in support of the Hanford site. There is the Battelle—Pacific Northwest Laboratory and a number of other contractors on that site.

The Hanford Environmental Health Foundation has all the medical records on the personnel on that site, and it is staffed by physicians and other occupational health and environmental specialists.

I think the answer to your question is that we call upon them periodically for advice. But if we request them to undertake some major survey which costs a sizable amount, we clearly would have to pay for that.

Mr. ROGERS. Are they on your payroll currently? Are they under contract to you?

Dr. WEYZEN. Yes.

Mr. ROGERS. All right.

Dr. WEYZEN. In the Hanford Environmental Health Foundation there are two programs supported by the Division of Biomedical and Environmental Research, with which I am familiar. One is the management responsibility for the transuranium registry; and the other one is the data collection effort for the Hanford Health and Mortality Study.

Mr. ROGERS. This is the responsibility of the Hanford Environmental Health Foundation?

Dr. WEYZEN. These are two BEIR projects which I know they are responsible for.

Mr. ROGERS. And you pay them for that.

Dr. WEYZEN. We pay them for that, yes.

Mr. ROGERS. By contract?

Dr. WEYZEN. By contract.

Mr. ROGERS. And what is the contract, the amount?

Dr. WEYZEN. The figures are in the hands of the committee. I believe it is $135,000 for the health and mortality study and $240,000 for the transuranium registry in fiscal year 1978.

Mr. ROGERS. Now, you used them to make an onsite inspection of the Charleston Naval Shipyard?

Dr. WEYZEN. That is correct.

Mr. ROGERS. Have you used them before, to do that?

Dr. WEYZEN. I have used Dr. Breitenstein several times, not for shipyards, but for laboratories and for reviews; yes, sir.

Mr. ROGERS. Was he paid separately for that?

Dr. WEYZEN. No, sir.

Mr. ROGERS. Did you pay his expenses down?

Dr. WEYZEN. No, no; that comes out of their budget.

Mr. ROGERS. So, they respond directly to any request you have.

Dr. WEYZEN. That is correct.

Mr. ROGERS. For the $200,000.

Dr. WEYZEN. Within the terms of the contract, there is an agreement, that when I need advice or consultation, which it is particularly qualified to perform, they can do it.

Mr. ROGERS. Even with a survey.

Dr. WEYZEN. Yes, sir.

Mr. ROGERS. And their findings and results are what?

Dr. WEYZEN. I received their findings and results yesterday, and I have copies for the committee.

Mr. ROGERS. Would you furnish those to the committee?

Dr. WEYZEN. You want me to summarize their findings?

Mr. ROGERS. Yes; if you would.

Dr. WEYZEN. There are three general areas they reviewed. One is industrial hygiene; second is the quality of the radiological protection program at Charleston, specifically, and at naval shipyards in general; and the third is the quality of the records as related to the possibility of doing a study of the workers of the shipyards.

Mr. ROGERS. Did they think there was a problem?

Dr. WEYZEN. They indicate that there does not appear to be a problem with regard to the quality of the records for doing a study.

Mr. ROGERS. And that is mainly what they looked at.

Dr. WEYZEN. That was one of the important points.

Mr. ROGERS. What else did they look at?

Dr. WEYZEN. They looked at industrial hygiene, and there were some critical comments by Dr. Reinert on some aspects.

Mr. ROGERS. What was he critical of?

Dr. WEYZEN. I will have to look it up, sir.

He said there was a distinct lack of records of industrial hygiene surveys performed before 1968. This is an important point because if you plan to study the population, it means that before 1968 you will not have adequate data to do a comparison of radiation exposure risks versus risk from other exposures. He also refers to the fact that they had a file cleanout, and that other data may be lost.

He mentioned that those records are not as easily retrievable as, for instance, radiation records, indicating there may be considerable time lost in trying to link the records. Prior to 1968 the records might be difficult to find, but, fortunately, the industrial hygienist who did the studies at that time is still employed by the Navy.

Another problem he refers to is that, in general, these records are general surveys and may lack the detail you need to link an exposure, for instance, to benzene, to a particular man.

Mr. ROGERS. So, what he is saying is that they have not kept very good records at Charleston.

Dr. WEYZEN. With regard to the industrial toxicants, yes, sir; that is what it indicates.

Mr. ROGERS. What about radiation records?

Dr. WEYZEN. According to all the comments, they are considered to be superb.

Mr. ROGERS. They are all right.

Dr. WEYZEN. Yes, sir.

Mr. ROGERS. Why did they go to Charleston, rather than Portsmouth?

Dr. WEYZEN. I cannot answer that question. The decision was made by the Navy that Charleston be selected for the initial walkthrough.

Mr. ROGERS. And then, when it was decided that you do the study at Portsmouth rather than Charleston, when was that decision made?

Dr. WEYZEN. Very recently; February 16, I believe.

Mr. ROGERS. How did you determine to change from Charleston to Portsmouth?

Dr. WEYZEN. I did not determine to change at all.

Mr. ROGERS. Who decided?

Dr. WEYZEN. The initial suggestion for a walkthrough at Charleston was made by Admiral Rickover; and I followed his suggestion.

Mr. ROGERS. Now, what about changing to Portsmouth, who made that judgment?

Dr. WEYZEN. That judgment to conduct a study at Portsmouth was made in the discussion between Mr. Miles and myself.

Mr. ROGERS. What brought that about?

Dr. WEYZEN. Because of the concern that had arisen around Portsmouth because of the newspaper article.

Mr. ROGERS. Were there any memorandums of that?

Dr. WEYZEN. No, sir.

Mr. ROGERS. Did you see any of the articles?

Dr. WEYZEN. I saw the article in the Boston Globe, yes.

Mr. ROGERS. Was it brought by Mr. Miles to you?

Dr. WEYZEN. Yes; it was.

Mr. ROGERS. Did he bring any other material?

Dr. WEYZEN. No, sir, except later on I received a copy of what I believe was a press release, that you have.

Mr. ROGERS. You did see that.

Dr. WEYZEN. I saw that.

Mr. ROGERS. How did you get that?

Dr. WEYZEN. I received that from Mr. Miles.

Mr. ROGERS. Have you had further discussions with Mr. Miles?

Dr. WEYZEN. We have had a number of telephone discussions, yes.

Mr. ROGERS. About what?

Dr. WEYZEN. About Portsmouth Naval Shipyard.

Mr. ROGERS. Excuse me.

Dr. WEYZEN. About Portsmouth Naval Shipyard.

Mr. ROGERS. To what degree, and what line of conversation?

Dr. WEYZEN. I remember one conversation on planning to go to Johns Hopkins to talk about what we would need in terms of records to do a study; a variety of subjects. I may be able to find them in my telephone log.

Mr. ROGERS. What happened in the meeting of February 23? On February 16, Mr. Miles brought the article from the Boston Globe and told you to switch the study from Charleston to Portsmouth. Then, on February 23, what happened?

As I understand it, Mr. Miles was present with you and the people from Johns Hopkins University.

Dr. WEYZEN. Mr. Miles and I met with the people at Johns Hopkins University and Mr. Miles briefed them on the radiological control program. He told them about the story in the Boston Globe. We discussed what one would need to do a study; whether those files and records were present; the type of work that would be needed to link the records, et cetera. The decision to do a study at Portsmouth was made on the 16th, 3 days before the newspaper article.

Mr. ROGERS. Have you had the Oak Ridge Associated Universities, or the Hanford Environmental Health Foundation do a survey of Portsmouth?

Dr. WEYZEN. No.

Mr. ROGERS. Have you had anybody do that?

Dr. WEYZEN. No, sir.

Mr. ROGERS. Do you plan to have them do it?

Dr. WEYZEN. One is planned. It is difficult to get the Johns Hopkins people together on the same date because of their teaching obligations. But there is one planned for March 17, I believe.

Mr. ROGERS. And when did you get the report on the Charleston survey, did you say today?

Dr. WEYZEN. It came in yesterday.

Mr. ROGERS. Was that furnished also to Mr. Miles?

Dr. WEYZEN. No, sir; Mr. Miles has not seen that.

Mr. ROGERS. Did Mr. Miles make any suggestions as to the initiation and design of an epidemiological study?

Dr. WEYZEN. Mr. Miles has expressed repeatedly that he thinks it is an urgent matter. He has not at any time discussed or made remarks about the design of the study.

Mr. ROGERS. I see he was present when you discussed that matter with the Johns Hopkins people.

Dr. WEYZEN. Yes, sir.

Mr. ROGERS. Why was it necessary for him to be present if it was turned over to the Department of Energy, and he said he met with you and had one letter, and that was all the correspondence?

Dr. WEYZEN. Sir, I have never been to a shipyard. Since he knows a shipyard inside out, he can present the Johns Hopkins people with information they needed.

Mr. ROGERS. That is why I wondered why you came to the Department of Energy. You have to be present when contracting with all the information. Well, I won't pursue that with you at this time. Dr. Carter.

Mr. CARTER. Thank you, Mr. Chairman.

Did you state that Mr. Miles had a concern that there was increased disease in populations around the nuclear installation? Is that not true?

Dr. WEYZEN. Yes, sir.

Mr. CARTER. And what was the basis for that concern?

Dr. WEYZEN. To the best of my recollection, sir, this was based on indications of concern from telephone calls to the shipyard.

Mr. CARTER. Do you plan to conduct a study of the population that surrounds the naval base?

Dr. WEYZEN. Yes, sir. Oak Ridge National Laboratory, through the demography staff, has been conducting a study of the Oak Ridge area for the last 4 or 5 years.

Mr. CARTER. What have their findings been?

Dr. WEYZEN. No significant findings on adverse health effects, infant mortality, congenital malformations, or overall incidence of cancer.

Mr. CARTER. Nothing like the returns from Pittsburgh?

Dr. WEYZEN. No, sir.

Mr. CARTER. Have they found the effects of atomic fallout from the United States to be associated with any increased numbers of miscarriages, genetic malformations, and so on?

Dr. WEYZEN. That study is referred to and discussed in Dr. Patrick's papers.

Mr. CARTER. This may be the conclusion of one study, but over the years, we learn that we cannot rely on a single study.

Dr. LIVERMAN. That is correct, yes.

Mr. CARTER. Now, with respect to the studies that you are proposing to do on the workers, how long will they be followed, 15, 20, or 25 years?

Dr. LIVERMAN. You are thinking about the medical followup studies I just referred to earlier?

Mr. CARTER. Yes, sir.

Dr. LIVERMAN. Until the workers are dead.

Mr. CARTER. Until they are dead?

Dr. LIVERMAN. Yes.

Mr. CARTER. Why did you decide to pick 5 rem and above as cutoff level?

Dr. LIVERMAN. Five rem is not for just following the people. The 5 rem group will be looked at in the medical examination followup as opposed to those in the epidemiological study. We believe that those over the 5 rem exposure in a given year, and perhaps they might have exposures 3 or 4 years above the occupational level, hopefully not. The people in that group are more likely to show effects that could be detectable in a medical examination. Those that are below that level will be followed only if they have complaints of some kind. If it appears that they have, then a medical examination of all the individuals will be important.

Mr. CARTER. Yes, sir. In fact, Dr. Radford proposed that it be lowered to one-tenth of that, is that not correct?

Dr. LIVERMAN. Dr. Radford?

Mr. CARTER. Yes, sir.

Dr. LIVERMAN. Yes, that was, I believe, in his testimony.

Mr. CARTER. All right, sir. Why have the film badges which were used 15 or 20 years ago meant virtually nothing in terms of their ability to record accurately radiation exposure?

Dr. LIVERMAN. What did they mean?

Mr. CARTER. Yes, sir, have they shown anything or not?

Dr. LIVERMAN. Well, obviously, I think you know the answer; the film badges are not as sensitive as the thermoluminescent dosimeters that the admiral talked about. They do provide an indication to give you an estimate of the whole-body dose.

Mr. CARTER. An estimate or a guesstimate? We just have heard testimony to the effect that for 15 years or more ago they were of virtually no use. I believe you heard that testimony, Doctor.

Dr. LIVERMAN. Yes, sir. I believe what the man was referring to was that if he had a dosimeter on his pocket with a cardboard cover on it and he sweated on it, it might not give the correct dose.

Mr. CARTER. That wasn't the gentleman from CDC?

Dr. LIVERMAN. I was not in the room when Dr. Foege testified.

Mr. CARTER. Dr. Foege raised the issue; that's why I asked the question.

Dr. LIVERMAN. We would utilize——

Mr. CARTER. This would mean, my friend, that the film badges used at Smoky were no good, according to Dr. Foege's testimony, or at least of very doubtful assistance in recording radiation exposure.

Dr. LIVERMAN. DOE and everybody else throughout the world, for a long time, used the film badge dosimeter because that was the only dosimeter that was available at that time.

Mr. CARTER. Yes, sir.

Dr. LIVERMAN. To measure it accurately.

Mr. CARTER. The film dosimeter was unreliable as an indicator of radiation exposure.

Dr. LIVERMAN. Well, certainly not totally accurate.

Mr. CARTER. Actually, we have learned a good deal more about the types of exposure.

Dr. LIVERMAN. Yes; there is evidence one must change one's mind.

Mr. CARTER. There has been a gradual evolution of things, from uncontrolled use of the bomb until we learned more and more about it. As we have learned more, the testing was moved further and further underground, and more constraints have been place upon it.

Dr. LIVERMAN. As we develop better instrumentation, obviously, we can be more sensitive in our measurement. I think that is an important consideration, too.

Mr. CARTER. Certainly. What is the level at which radiation would be dangerous? Or, what is the safe level?

Dr. LIVERMAN. I think we have heard it said here before, and I would have to agree, I am not sure that there is a safe level.

Mr. CARTER. Thank you, sir.

Mr. ROGERS. Mr. Miles, would you mind joining us at the table? I have a question or two I think need to be asked. I would appreciate it if you would. Dr. Weyzen, did you make available a copy of the report of your meeting with your staff of the Division of Naval Reactors 71-77 to Mr. Miles?

Dr. WEYZEN. Yes, sir.

Mr. ROGERS. Pardon?

Dr. WEYZEN. I sent it to Mr. Miles, yes, sir.

Mr. MILES. Yes; I have seen it.

Mr. ROGERS. Do you have a copy of that in your files, Mr. Miles?

Mr. MILES. I think I do, yes, sir.

Mr. ROGERS. Did you furnish that to the committee?

Mr. MILES. I will have to check. Apparently there is a disconnect on what you did get provided, so maybe that's the reason you have been pushing those questions. I did not see myself what was handed to the committee. Other people took care of that from other offices, so I am not sure what they gave you now. I will go back and check.

Mr. ROGERS. How could they handle that without your being the focal point? You are the ones who give the orders, you answer the phone, you get the oral instructions, you get the memorandum. But you are not aware of what they were furnishing?

Mr. MILES. They furnished a large bulk of information of questions and answers and newspaper articles.

Mr. ROGERS. No; I am talking about the committee's request.

Mr. MILES. Yes, sir. Another office has that. I have not seen the committee's request, even. I personally have not seen it. Other people put that together.

Mr. ROGERS. Were you advised of it?

Mr. MILES. Yes.

Mr. ROGERS. Did you look at any of the material?

Mr. MILES. No.

Mr. ROGERS. You haven't seen any of the material that was given to the committee?

Mr. MILES. No.

Mr. ROGERS. Who gathered the materials?

Mr. MILES. I am not positive.

Mr. ROGERS. Do you have any idea?

Mr. MILES. Yes; I think.

Mr. ROGERS. Who did?

Mr. MILES. Mr. Wegner gathered it.

Mr. ROGERS. Mr. Who?

Mr. MILES. Wegner, Deputy Director.

Mr. ROGERS. Deputy Director of?

Mr. MILES. Of Naval Reactors.

Mr. ROGERS. Of Naval Reactors. I thought your earlier testimony was that we had it all.

Mr. MILES. I will doublecheck, sir.

Mr. ROGERS. I believe that was your testimony before, was it not?

Mr. MILES. I thought you had it all, yes, sir. You have certainly all that we originated, because the only thing we originated was the December 30 memo.

Mr. ROGERS. That is not the request. I asked any memos.

Mr. MILES. I will go back and check the request and double check what was provided.

Mr. ROGERS. In fact, I don't think you furnished us anything.

Mr. MILES. If there is anything else, I will provide it.

[The following information was received for the record:]

On February 22, 1978, Mrs. Esther Cassidy, Office of Congressional Affairs, called Mr. William Wegner, Deputy Director for the Division of Naval Reactors. She had received a call from the staff of the Committee requesting a copy of all correspondence dealing with the Navy's request to the Department of Energy to perform human health studies on naval shipyard workers. On February 24, 1978, a copy of a letter from Admiral H. G. Rickover, Director, Division of Naval Reactors, to Dr. James L. Liverman, Acting Assistant Secretary for Environment, dated December 30, 1977, and a letter from Walter H. Weyzen, Manager, Human Health Studies Programs, Division of Biomedical and Environmental Research to Murray Miles, Chief, Nuclear Technology Branch, Division of Naval Reactors, dated December 21, 1977, were provided to Mrs. Cassidy. These were the only memos held by the Division of Naval Reactors on this subject. Mrs. Cassidy provided these documents to Dr. Burke Zimmerman of the Committee staff on Friday, the 24th of February.

Mr. ROGERS. Anything you received from DOE.

Mr. MILES. OK. I have on the mortality study one or two memos that I got from Dr. Weyzen, and there are separate memos on the subject of Dr. Patrick's demography study which weren't part of the request, as far as I know. I have a number of papers on the demography study. I have compiled a lot of information from the naval shipyards and where the workers live, for example, I have got a file that thick on Dr. Patrick's studies.

Mr. ROGERS. That is what we thought——

Mr. MILES. That were not part of this discussion.

Mr. ROGERS. Well, I thought we were trying to get at all radiations studies involved in the health problem of the ——

Dr. LIVERMAN. Mr. Chairman, may I?

Mr. ROGERS. Maybe we have to articulate every description. That has been the problem with CDC when they try to get cooperation they say, well, you give us their names and then we will see if we can give you some records. We gave you a general request, we thought was fairly clear. We had discussions with your liaison, who was an admiral, and yet somehow all of the memos from DOE and some studies you have done on the effects of radiation are around but not furnished by you to the committee. Now we find out because DOE did furnish materials that you have not discussed with us the problem of the people around the shipyards. This comes out with information from DOE. Why did you withhold that information, Mr. Miles?

Mr. MILES. I have not withheld it, sir. I have not been asked about that study.

Mr. ROGERS. Well, don't you think that it's a fine point when we are trying to get to the problem of radiation and its effect, simply not to mention it when you have done studies on it, when I asked for memorandum regarding health effects of radiation, and you don't furnish it to us? Would you not feel that is somewhat evasive?

Mr. MILES. I will have to check the records and the request, sir.

Mr. ROGERS. Well, may I tell you the committee feels it is evasive. And this increases my concern with the prior charges mentioned by Senator McIntyre, Senator Hathaway, of the concerns of the difficulty of getting cooperation from the Navy. Well, this committee plans to do it and plans to have it. If you can't come up we will have the Secretary here.

Now, we made an error in excusing the Secretary, and we will have another hearing. If we have to have the Defense Secretary himself, we will do that. But we plan to get to the bottom of this. And it would be helpful if you would simply be open with us. That is all we ask.

Now, let me ask this. You told us you went over it because of this Hanford study, at least this is what I got from your testimony, Mr. Miles. That is really what triggered this concern.

Now, the DOE says the reason you went over it was because you were getting some reports that there were increased instances of death or health effects around the shipyards. Is that true?

Mr. MILES. No, sir, it is not true.

Mr. ROGERS. Then their statement is wrong?

Mr. MILES. Yes, sir, it is wrong.

Mr. ROGERS. Well, then where did you get it, Dr. Liverman?

Dr. LIVERMAN. I don't believe that that is what our statement says here.

Mr. ROGERS. It says Mr. Miles identified two problems at the Portsmouth Naval Shipyard. That there appears to be an increased disease incidence in populations that live around the nuclear installation.

Mr. MILES. I can explain how I think they misinterpreted.

The statement as written is not exactly correct: it is a misinterpretation.

Mr. ROGERS. You may explain.

Mr. MILES. I have lived through numerous studies in the past where people have examined the death rate of populations around nuclear facilities and charged those death rates against the environmental discharges from this facility. We have had charges made at a number of places in our program for that kind of purpose. I thought it was a good idea and discussed with Dr. Weyzen on the

13th of December at the initial meeting why can't DOE do a simple study, using National Cancer Institute statistics and infant mortality statistics, to get a simple kind of quick study to see is there an effect in the environment. It is certainly better for us to know about it first before somebody else goes and looks at it and finds out about it. If we know about it, maybe we can go look into it and find out what the problem was, if there is one.

I am not aware of such a problem at Portsmouth. I wasn't aware of it at the time and am still not aware of a problem in the counties surrounding Portsmouth.

Mr. ROGERS. What about Charleston?

Mr. MILES. But I would like to look at it.

Mr. ROGERS. What about Charleston?

Mr. MILES. No place.

Mr. ROGERS. Any other naval shipyards?

Mr. MILES. I am not aware of any others at the moment except one specifically Dr. Weyzen quoted to me in the Oakland area around San Francisco.

Mr. ROGERS. Has there been an increased incidence of disease there?

Mr. MILES. Oakland, apparently that area which is fairly close to the Mare Island Naval Shipyard apparently has a higher rate of cancer than the others, he said. And that was his support for agreeing with this kind of a study, and that is why he called Dr. Patrick in halfway through our meeting to talk.

Mr. ROGERS. Had you had any reports of that increased incidence?

Mr. MILES. No, sir.

Mr. ROGERS. Had you had any study done?

Mr. MILES. No, sir. There was a specific report in the newspapers in Bremerton, Wash., a year or two ago which was countered very quickly by a local doctor and subsequently by the local, by the State health people.

Mr. ROGERS. What about the increase in communications from populations that live around the nuclear installations?

Dr. WEYZEN. I said that, sir.

Mr. ROGERS. All right, what about that?

Dr. WEYZEN. It was my assumption that indeed the community had made an indication that there was concern.

Mr. ROGERS. Is that right?

Dr. WEYZEN. I don't know if that is correct.

Mr. MILES. That is a hypothetical one. I would like to be armed for that. I would have liked to have looked into that. That was the purpose for that.

Mr. ROGERS. In other words, it was not activated by anything, your attention was not called to this problem by any telephone calls or any communications from your shipyard people?

Mr. MILES. That is correct.

Mr. ROGERS. Or from the community?

Mr. MILES. That is correct.

Mr. ROGERS. So you just simply met with him to identify two problems?

Mr. MILES. The demographic study of the surrounding counties is what I was talking about.

Mr. ROGERS. Now, who did those studies for you?

Dr. WEYZEN. The demographic study that was ongoing at the time of the meeting was being done by the Oak Ridge National Laboratory, by Dr. Patrick, of the population surrounding Oak Ridge for the past 4 or 5 years. At the time of my meeting, Dr. Patrick happened to be in the office building and I asked him to sit in on the meeting, to give us his advice as to feasibility including these kinds of studies around other nuclear facilities.

Mr. ROGERS. So you have received no calls indicating any concern from your shipyard commanders?

Mr. MILES. Correct. That is a long-term concern of mine.

Dr. LIVERMAN. Mr. Chairman, may I?

Mr. ROGERS. When did it first begin?

Mr. MILES. Me personally? Fifteen years ago, probably.

Mr. ROGERS. And you have had no studies done during the 15 years?

Mr. MILES. That is correct.

Mr. ROGERS. Why not?

Mr. MILES. I don't have the capability to run those studies.

Mr. ROGERS. Well, you have just got this one studied.

Mr. MILES. Dr. Weyzen's predecessors would not agree to them at the time I went to meet with them.

Mr. ROGERS. Who did you meet with?

Mr. MILES. Sidney Marks.

Mr. ROGERS. Dr. Marks would agree to them?

Mr. MILES. That is correct.

Mr. ROGERS. Were you aware of that?

Mr. MILES. No, sir, I was not.

Mr. ROGERS. Dr. Liverman?

Dr. LIVERMAN. No, sir, I was not.

Mr. ROGERS. Would you check that out and ask the Inspector General to check that out for us?

Dr. LIVERMAN. Yes; I will do that. I am certainly not aware of it.

Mr. ROGERS. When did you have that, Mr. Miles?

Mr. MILES. I don't recall specific dates.

Mr. ROGERS. Generally.

Mr. MILES. The general subject was brought up 2 or 3 years, not on a high level, I will have to admit that. I did not ask Admiral Rickover to write a letter asking for these studies.

Mr. ROGERS. Yes, but you are the admiral's assistant; you speak with his authority.

Mr. MILES. The answers to the questions were in each of the cases when I brought it up; if one does such a study, one will find a large number of effects from some causes the presumption is radiation is a far smaller cause than the large number of problems in a highly industrialized shipyard, with lots of problems of an industrial hygiene variety.

Once you find a problem, you have to pursue it all the way, you can't drop it. You have to go find out what caused that problem, or it's your fault that you didn't go so far. And you had better not start finding those problems, or you will be locked in with very difficult, very long, very expensive studies. That was my interpretation of his approach.

Mr. ROGERS. Then you have discussed it with him on many occasions, then?

Mr. MILES. Several. Two or three, four.

Mr. ROGERS. Beginning about when?

Mr. MILES. 1968, I know of.

Mr. ROGERS. Would you let us——

Mr. MILES. I don't think I have much—I don't think I have records of it. I remember one discussion at a 2-year-ago national meeting, March 1976.

Mr. ROGERS. You discussed it then?

Mr. MILES. Yes.

Mr. ROGERS. Why was it if you had such concern that you had discussed it three and four times that you didn't initiate some action or talk to the admiral or talk to some of your own people to get a study going if the Department of Energy didn't want to do it?

Mr. MILES. The admiral answered that question earlier.

Mr. ROGERS. Well, I don't recall the answer. Suppose you give the answer.

Mr. MILES. I think it was his view of it that he couldn't, Admiral Rickover can't take on everything. He has to take on some things. Here was one that had not got high enough priority.

Mr. ROGERS. I thought you didn't discuss it with the admiral.

Mr. MILES. I did not discuss this subject with him until this December.

Mr. ROGERS. Well, then why do you blame it on the admiral taking no action, if you could have initiated some action?

Mr. MILES. I didn't mean to—that was in error.

Mr. ROGERS. Well, I would think it is an error. Now, what I want to know is if you could get this one started, and you did it through your meetings, why didn't you get it started before if you had expressed that concern over four or five times with Dr. Marks, and I want to know why Dr. Marks didn't respond. Why didn't you do something, Mr. Miles?

Mr. MILES. I don't have an answer. I didn't do it.

Mr. ROGERS. Dr. Weyzen, how did you get this, such a wrong impression that he had identified two problems at the Portsmouth Naval Shipyard and now Mr. Miles says, oh, I wasn't talking about that at all.

Dr. LIVERMAN. Mr. Chairman, may I try to respond?

Mr. ROGERS. Yes; I would like. Who wrote this testimony, Dr. Weyzen?

Dr. WEYZEN. I developed information, but I did not write it.

Dr. LIVERMAN. No, sir, Dr. Weyzen did not write this testimony.

Mr. ROGERS. Well, who wrote this?

Dr. LIVERMAN. It was written over the weekend by members of my staff. Would you please look at the December 21 files memo of Dr. Weyzen's?

Mr. ROGERS. Yes; we have that.

Dr. LIVERMAN. I believe that the intent of what both Dr. Weyzen and Mr. Miles say is in this sentence: they met to, quote, discuss current status of the health effects from radiations end quote. What has happened, in the course of writing the statement, because Portsmouth is the subject of the hearing, is that Portsmouth got woven into a sentence of the statement. The more accurate record of the meeting appears in paragraph 1 of the December 21, files memo.

Mr. ROGERS. Well, it says error, persistent problem is incompleted case of disease incidence.

Dr. LIVERMAN. The statement does say that.

Mr. ROGERS. Cancerous infant mortality in populations surrounding the nuclear facilities.

Dr. LIVERMAN. Naval reactor facilities?

Mr. ROGERS. Yes.

Dr. LIVERMAN. Dr. Weyzen can speak to that.

Mr. ROGERS. All right.

Dr. WEYZEN. That is how it came through to me from Mr. Miles. If my perception is wrong, I have to apologize to the committee.

Mr. ROGERS. Well, I think it goes beyond apologizing when you have a meeting that is rather important to the health of people and we can't even communicate face to face and get the same understanding.

Mr. Miles doesn't like to write memoranda: he does it by telephone most of the time. And now you're telling me, at a face to face discussion, you even get the wrong impression. That doesn't give very much confidence to the committee that the health of people exposed to radiation is going to be taken care of.

Dr. LIVERMAN. May I comment?

Mr. ROGERS. Yes; you may, Dr. Liverman.

Dr. LIVERMAN. I think the comment which Dr. Weyzen made in his memo about the quote, repeated claims, end quote, is a correct statement; if not in relation to naval reactor facilities, to reactor facilities in general. There have been a large number of cases, Michigan being one of the best known, where there have been a number of reports from people expressing concern about whether or not there would be danger from a nuclear facility being located in their vicinity. That is a very general problem or claim that comes up in most discussions of environmental impacts. When the Nuclear Regulatory Commission starts reviewing whether they should or should not grant a license, these general concerns come out every time.

So I think this is a fairly well-known phenomenon without regard to naval reactor facilities per se.

Mr. ROGERS. Is it your feeling now that the results that we have had to date, and accepting them at face value, raise serious concern about the adequacy of exposure standards, Dr. Liverman?

Dr. LIVERMAN. Sir, I believe that there is some question about the adequacy.

Mr. ROGERS. Well, this is your statement, I have quoted your statement to the committee today, and I have just asked you if that is in effect your position today?

Dr. LIVERMAN. That the standards are too——

Mr. ROGERS. Talking about the studies, these results, if accepted at face value.

Dr. LIVERMAN. Yes, sir.

Mr. ROGERS. And I understand, raise serious concerns about the adequacy of exposure standards.

Dr. LIVERMAN. Clearly if the results are confirmed, I agree, yes, that is correct.

Mr. **Rogers.** I have a number of further questions; however, it is late.

Dr. **Liverman.** Be glad to answer any questions for the record if the committee wishes it.

Mr. **Rogers.** We will probably have to have additional hearings. I would hope, Mr. Miles, that we can get all the memoranda.

Mr. **Miles.** Yes, sir.

Mr. **Rogers.** The committee doesn't intend just to let this ride. We will follow through and we will appreciate cooperation. We are not trying to blame people, we are trying to get at the problem of what happened, the judgment, the decisionmaking, what needs to be done to correct it and to get something done. Also, Dr. Liverman, I am very much concerned about your statements that are presented to the committee, evidently that are not giving us a true statement of your staff's interpretation of what has happened and I would hope that you would look into that and let us have assurances as to who is writing this and what is going on.

Dr. **Liverman.** I certainly will.

Mr. **Rogers.** Because we have to depend on your statement.

Dr. **Liverman.** I certainly will, sir. I apologize to the committee for the error and will provide a correction to my statement.

[The following information was received for the record:]

On December 13, 1977, officials of the Office of Environment met with Division of Naval Reactors personnel at that Division's request. The attendees were Mr. M. Miles and W. Kindley, Division of Naval Reactors; Dr. W. Weyzen, Manager of Human Health Studies, Division of Biomedical and Environmental Research; Dr. W. R. Albers, Chief, Occupational Medicine Branch, Division of Operational and Environmental Safety; and Dr. C. Patrick, Leader, Demographic Program at the Oak Ridge National Laboratory.

The principal purpose of the meeting was to discuss current information on the effects of low level radiation. In the course of the discussion, Mr. Miles identified two public concerns regarding nuclear shipyards—that there appears to be an increased disease incidence in populations that live around the nuclear installations, and that working in the shipyard could be associated with increased morbidity and mortality. My staff advised Mr. Miles that such claims can only be answered by collecting morbidity and mortality information on these populations and evaluating it.

As a result of the meeting, Dr. Weyzen requested Oak Ridge National Laboratory to undertake the responsibility for initiating a systematic collection of demographic information on populations living around shipyards involved in the nuclear propulsion program. The data collection and analysis are in progress; however, it is too early in the evaluation to reach preliminary conclusions concerning the general health of populations living in the vicinity of shipyards. It was also decided that a review of a representative shipyard should be made and that the personnel record system would be inspected to assess the potential for an epidemiological study of the morbidity and mortality of the nuclear propulsion program workers.

Mr. **Rogers.** And I would like to have provided for the record any claims, telephone conversations, and discussions, of increased incidences of health disease within or surrounding the nuclear installations and particularly the shipyards.

Dr. **Liverman.** I will gladly supply copies of public expressions of concern regarding the safety of nuclear facilities.

[Testimony resumes on p. 1453.]

[The following material was subsequently received for the record:]

ALIQUIPPA, PA
15001

NOTE:
1974

DEAR DR. RAY:

LAST YEAR, WHEN I FIRST NOTED DAMAGED PLANTS, DR. STILL OF ENV. BIO-MED. RES. REASSURED ME THAT BECAUSE THE SHIPPINGPORT PLANT WAS JOINTLY OPERATED BY THE ① NAVY
② A.E.C.
③ DUQUESNE LIGHT Co.

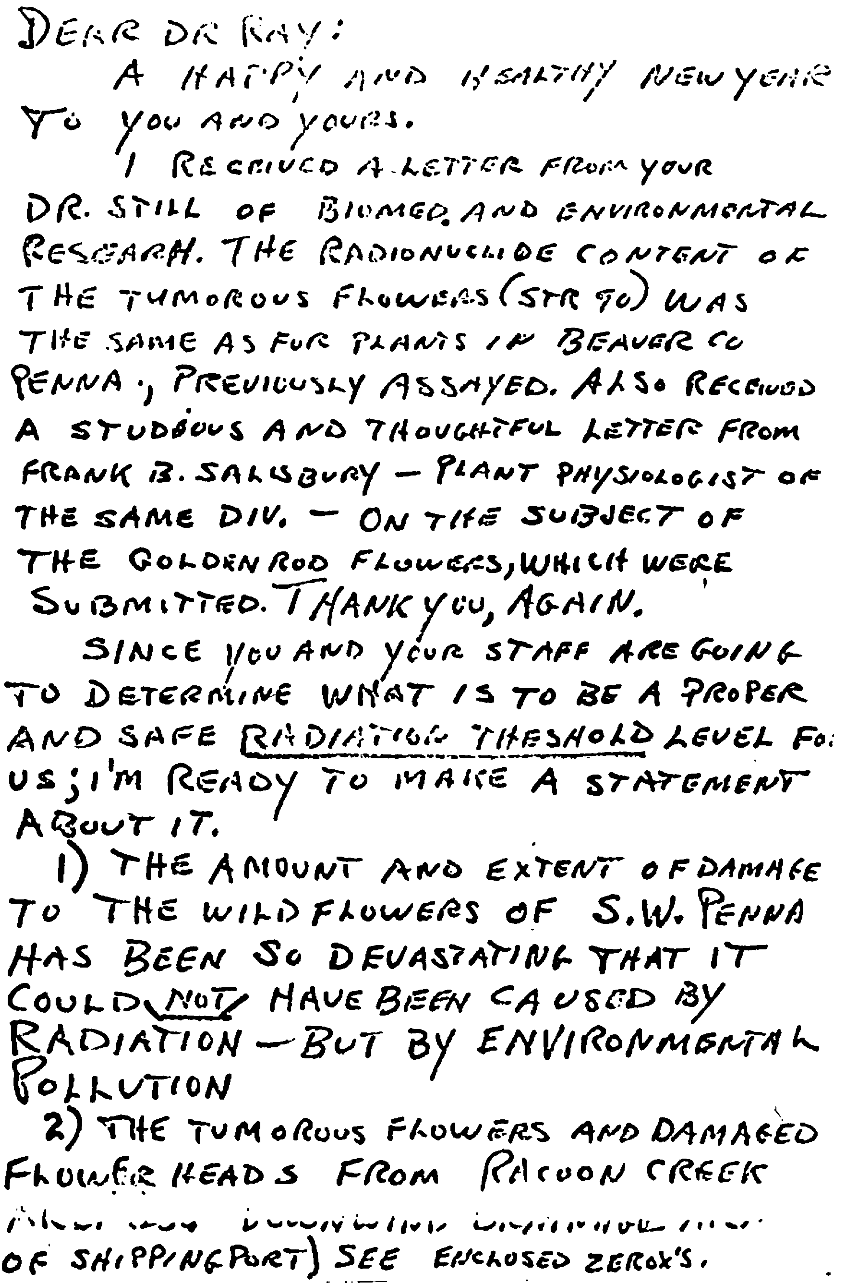
THERE COULD BE NO QUESTION THAT WHEN THE PLANT REPORTED VIRTUAL ZERO EMISSIONS THROUGHOUT THE YEARS, THAT THAT INDEED WAS THE CASE.

THIS NEWS CLIPPING NOW REVEALS A VAST CREDIBILITY GAP.

YOU ARE NEW ON THE SCENE AND CREDIBLE.

PLEASE DONT LET THIS CLIP GET BY YOU.

Sincerely



DEAR DR RAY:

A HAPPY AND HEALTHY NEW YEAR TO YOU AND YOURS.

I RECEIVED A LETTER FROM YOUR DR. STILL OF BIOMED. AND ENVIRONMENTAL RESEARH. THE RADIONUCLIDE CONTENT OF THE TUMOROUS FLOWERS (STR 90) WAS THE SAME AS FOR PLANTS IN BEAVER CO PENNA., PREVIOUSLY ASSAYED. ALSO RECEIVED A STUDIOUS AND THOUGHTFUL LETTER FROM FRANK B. SALISBURY – PLANT PHYSIOLOGIST OF THE SAME DIV. – ON THE SUBJECT OF THE GOLDENROD FLOWERS, WHICH WERE SUBMITTED. THANK YOU, AGAIN.

SINCE YOU AND YOUR STAFF ARE GOING TO DETERMINE WHAT IS TO BE A PROPER AND SAFE RADIATION THESHOLD LEVEL FO US; I'M READY TO MAKE A STATEMENT ABOUT IT.

1) THE AMOUNT AND EXTENT OF DAMAGE TO THE WILD FLOWERS OF S.W. PENNA HAS BEEN SO DEVASTATING THAT IT COULD NOT HAVE BEEN CAUSED BY RADIATION – BUT BY ENVIRONMENTAL POLLUTION

2) THE TUMOROUS FLOWERS AND DAMAGED FLOWER HEADS FROM RACOON CREEK [illegible] OF SHIPPINGPORT) SEE ENCLOSED ZEROX'S.

2

2) THE PEOPLE WHO LIVE IN S.W. PENNA MOST CERTAINLY ARE SATURATED WITH THESE SAME ENVIRONMENTAL CHROMOSOMAL ANTAGONISTS. THEREFORE, AN ACCEPTABLE THRESHOLD HERE MUST BE LOWER THAN ONE WHICH WOULD BE ACCEPTABLE ON THE OUTER BANKS OF N.C., FOR EXAMPLE.

Sincerely

S. J. Won

OPA
Kaufman ( )
4223

BER.

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COMMITTEES:
FOREIGN AFFAIRS

SUBCOMMITTEES:
NEAR EAST AND SOUTH ASIA
(CHAIRMAN)
EUROPE
ASIAN AND PACIFIC
AFFAIRS

Congreſs of the United States
House of Representatives
Washington, D.C. 20515

April 2, 1974

1974 APR 4 PM 3 03
OFFICE OF THE SECRETARY
RECEIVED

Dr. Dixy Lee Ray, Chairman
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Dr. Ray:

In connection with the proposed construction of several nuclear power plants in and near my district, I have begun to study some of the controversial issues surrounding nuclear power. A number of questions have come to my attention, and I would appreciate hearing your views. As planning for the proposed power plants progresses, I expect an increasing number of inquiries from constituents. My questions relate to a number of areas, and your answers will be most helpful.

1) Waste storage and disposal

PHW4

What is being done to insure that there will be no more leaks of the type that have occurred at the Hanford reservation in Washington?

OPA

In the absence, up to this time, of a definitive disposal method, is it wise to speed up the construction of power plants?

WM&T

What do you see as the ultimate solution for disposal of radioactive wastes, and how long do you think it will take to devise a method of waste storage that will permit no leaks for many thousands of years? As one of my constituents put it, "the time required for waste disposal is greater than the life of any social or governmental system in history or any we might expect in the future. Therefore, the continuity of careful maintenance would almost certainly be broken".

WM&T

In studying alternative methods of waste disposal, are you making the assumption that future generations will be as technologically advanced as we are and capable of handling any problems?

2) Problems with transportation and sabotage

WM&T

What would be the consequences if one of the trucks carrying nuclear waste jackknifed in a road accident?

wm 47 Just how difficult would it be under present circumstances for a group of determined individuals to confiscate, while in transit, a quantity of nuclear material sufficient to a) produce a crude explosive device: or b) cause harm to others if the material were simply released into the atmosphere or into an enclosed area?

wm 47 How difficult would it be to do these same things by stealing the materials from a nuclear power plant?

3) The plant itself

BER [illegible] How much harm do permitted levels of thermal pollution inflict on fish?

R.S How can the Atomic Energy Commission be certain that the risks of failure of the emergency core cooling system are acceptably low, when a full-scale test of the system has never been conducted?

R.S If an ECCS failure were to take place, despite odds against such an event, what might be the consequences?

R.S If nuclear power plants are indeed safe, why are they not being built in large metropolitan areas? At least one nuclear power company claims that locating plants at a distance from population centers is one additional means of improving safety. How am I to reassure my constituents when they hear that safety for city populations may mean greater risks for rural residents?

R.S What will happen if a plane crashes into a nuclear reactor?

BER Grain What is your evaluation of the statistics of Dr. Sternglass on the abnormal risk of disease among pregnant women and young children who live within a 25-minute radius of a nuclear reactor?

RRD What is done with radioactive metal tailings from nuclear plants?

RRO If a nuclear plant were shut down as the result of an earthquake in the vicinity (despite siting regulations to minimize chances of such an event), how long would it take to restore electricity to the area?

BER Stail How does the AEC determine what constitutes "acceptable" exposure levels to radiation? Are AEC standards widely accepted by the scientific community?

4) The breeder reactor

[illegible] the fact that the breeder reactor will breed highly toxic plutonium be any deterrent to its development?

RRD The breeder would use uranium much more efficiently than do present reactors. If for some reason the breeder turns out to be less promising than originally expected, would we not become just as dependent on foreign countries for our uranium supplies as we are now for conventional fuels?

5) Alternative sources of energy

OPA Has experience with the safety problems of nuclear power plants produced any feeling within the AEC that we need to vastly step our research on cleaner sources of fuel, such as geothermal, solar, and hydrogen energy?

OPA What levels of progress might we expect if we devoted the same amount of effort to these kinds of energy as we have spent on nuclear power?

CTR To what extent will the development of fusion power solve waste disposal problems and other difficulties with the burner and breeder reactors?

OPA Is the President's announced goal of energy independence by 1980 realistic? If so, can it be met without sacrificing safety or environmental quality?

I appreciate your taking the time to consider these questions, and look forward to hearing from you.

Sincerely,

LEE H. HAMILTON, M.C.

LHH:ac

JUL 29 1974

Honorable Henry M. Jackson
United States Senate
802 United States Court House
Seattle, Washington 98104

Dear Senator Jackson:

We are pleased to provide comment on the article enclosed in the letter you received from Mr. Richard W. Durham, Jr., of Ararat, North Carolina. Mr. Durham's letter is dated July 1, 1974.

The article, "Bone Cancer and Your Children" by Harold J. Taub, is a skillful presentation of untruths interwoven with just enough of popular public issues, i.e., nuclear energy and cancer, to readily attract the eye of any casual reader. It is apparently designed to help sell a book he has recently published, but does not contain any substantive fact about the conclusions he implies can be drawn, but which he so artfully avoids making. A few examples follow to indicate the degree to which Mr. Taub has distorted his presentation.

The opening of the article states it looks to him as if more bone cancer is occurring. He doesn't say more bone cancer is occurring. To document this, he uses a newspaper article which gives an estimate of new cases of bone cancer toward the end of 1973 to be about 5% higher than the American Cancer Society (ACS) had "predicted" earlier in the year. The fact is that the ACS doesn't "predict" new cancer cases; it estimates them on the basis of previous years' actual cases and the population. The ACS further cautions that their estimate is "offered as a rough guide and should not be regarded as definitive(1). Additionally, contrary to what Mr. Taub implies, in 1971, the ACS estimated 2000 new cases of bone cancer. Copies of the appropriate tables from the ACS booklets for the years 1971 and 1973 are enclosed.

The statement on page 36, first paragraph that ". . . radiostrontium poisoning is the only known cause of bone cancer (other than metastases . . .)" is untrue. As a matter of fact, there are several radionuclides that have been shown to cause bone tumors in animal experiments, including plutonium and radium, and there is a large number of humans who developed bone tumors as a result of ingestion of radium in occupational situations many years ago. Additionally, we do not at this time know what causes the majority of any type of cancer, including bone cancer, but it is well known that a number of agents, including chemicals and viruses, can initiate the neoplastic process.

Mr. Taub, on the bottom of page 36 and immediately following on page 38, states that the Duquesne Light Company asked Dr. Sternglass to survey its Shippingport Nuclear Generating plant, that Sternglass uncovered startling results for infant mortality and leukemia, and that Duquesne Light, being displeased with his results, contracted for the "National Utilities Service Corporation" to do another study. This is a complete distortion and misrepresentation of what occurred. The Duquesne Company contracted with the Nuclear Utilities Service Corporation (NUS) to do environmental monitoring preparatory to a license request for construction of an additional nuclear reactor at Shippingport. Dr. Sternglass took the results of the NUS survey, which showed high levels of some nuclides in the area, and made a case for the high infant mortality rate in the nearby town of Aliquippa to be a result of radionuclides emitted from the presently operating reactor.

Subsequently, the AEC conducted an investigation of this matter and the findings are reported in the enclosed document, "Summary Report on the Assessment of Environmental Radioactivity in the Vicinity of the Shippingport Power Station" (WASH-1256-R1, August 1973). Briefly, the investigation showed that radioactivity in the area was hardly different from the background, that the NUS measurements were inaccurate, and that the claim by Dr. Sternglass that the Shippingport Station has contaminated the environment and resulted in increases in the frequency of leukemia and cancer cases and infant deaths is not substantiated. Additionally, the Governor of Pennsylvania convened a fact-finding committee regarding the Shippingport Nuclear Power Station to investigate the allegations of Dr. Sternglass. Their report, which was recently released, also did not substantiate any of Dr. Sternglass' allegations. Incidentally, Professor Morris H. DeGroot, of the Carnegie-Mellon University, whom Mr. Taub states confirms the studies of Sternglass, was a member of the Governor's Fact-Finding Committee.

The article could be further criticized, line by line, but we believe the above is sufficient to indicate the shallowness of its content and the distortion of the facts, whether inadvertent or deliberate. However, we do feel a comment is in order regarding the push for the use of daily dietary alginate by Mr. Taub. It is true that sodium alginate will remove strontium from the body. However, the picture is not as simple nor as optimistic as that portrayed by Mr. Taub.

The research that has been conducted with animals shows that 10 percent of the daily diet needs to be alginate, and for humans a minimum of 10 grams daily -- this hardly equates to the "little" advocated in the article. Further, the inconsistency between different batches of alginate is considerable and has led to the use of a term effective alginate by those who work with it for removal of trace nuclides. Stated differently, alginate comes from brown seaweed, and the effectiveness of it depends upon what species of algae made up the seaweed. Thus, a given quantity of one batch of alginate may remove 5 percent of the strontium nuclide whereas the same quantity of alginate from another batch may remove 90 percent. The daily intake of a little alginate would have little, if any, value, in our opinion, particularly in view of the minute quantities of radiostrontium that is being taken in and the large variability in effectiveness. We would not question its use in the case of a massive contamination and, indeed, we have invested in considerable research on other means of removing strontium from the body. There are several agents, including chelating compounds and certain antacids that are effective.

In summary, we find the article by Mr. Taub to contain nothing of substance and believe that it is a disservice to the public for such misconceptions to be presented.

I hope the above is helpful to you. If any additional information is required, please let me know. The correspondence from Mr. Durham is being returned as requested.

Sincerely,

Original signed by
James L. Liverman

James L. Liverman, Director
Division of Biomedical and
Environmental Research

Enclosures:
As stated

bcc: Cong. Relations (3)
GM
AGMBERSP
BERA
BP (Still)

GM-5903

DBER:BP
CARTER
7/24/74

DBER:A
BROTHERS
7/24/74

Route 1 Box 1-A
Ararat, N.C. 27007
July 1, 1974

Sir:

I suppose one could say that you are "energy-minded." That is why I am writing to you.

I understand that you are one of the members of the Joint Committee on Atomic Energy. I am writing in relation to the A.E.C. I recently read an article concerning the nature of A.E.C. inspection of nuclear plants in relation to bone cancer. Surprised? So was I. I would sincerely appreciate your opinion of the enclosed article in general and specifically the A.E.C.'s neglect in allowing such hazardous conditions to exist. Something needs to be done. The situation is this. We have not inherited the earth from our parents, but have borrowed it from our children. Let's keep it, and the children.

Sincerely yours,
Richard V. Durham Jr.

COMMONWEALTH OF PENNSYLVANIA
OFFICE OF THE GOVERNOR
HARRISBURG

MILTON J. SHAPP
GOVERNOR

October 18, 1974

'74 OCT 29 AM 10:48
OFFICE OF THE SECRETARY

Dixie Lee Ray, Ph.D.
Chairman
U.S. Atomic Energy Commission
Washington, D.C.

Dear Dr. Ray:

Early in 1973, Ernest J. Sternglass, Ph.D., made certain allegations concerning the effects of the operation of the Shippingport Atomic Power Station on the infant mortality and malignancy rates in communities in the facility environs. Toward our investigation of those claims, I appointed a Committee of experts to examine the basis of the controversy. The Committee, chaired by Leonard Bachman, M.D., held public hearings in the matter in July, 1973 at Aliquippa, Pennsylvania.

The report of the Committee including conclusions and recommendations was issued on June 26, 1974. A copy of that report is enclosed for your information.

We are most interested in expediting the implementation of the Committee's recommendations. Of particular concern is the fact that there is a duality of control at the Shippingport-Beaver Valley Power Plant site. This duality apparently led directly to the allegations of Dr. Sternglass which were based upon a Beaver Valley preoperational environmental monitoring survey program performed for the Duquesne Light Company by the NUS Corporation. The result of that preoperational program indicated higher than normal levels of radioactivity in the Beaver Valley-Shippingport environs.

Apparently, at no time did the Shippingport plant operating personnel become involved in this environmental monitoring program or know of the results of that program. It was also obvious that the Duquesne Company officials responsible for the Beaver Valley power plant construction were either unaware or unable to evaluate the effectiveness of the preoperational environmental program.

The Shippingport reactor is owned by the Division of Naval Reactors of the U.S. Atomic Energy Commission. It is operated by Duquesne Light Company but under the direct supervision of the Division of Naval Reactors. On the same site are two proposed Duquesne Light nuclear power reactors--the Beaver Valley Power Stations Units I and II.

The Committee, during the public hearings and in discussions following the hearings, felt that there was a complete lack of communications between the two facilities. On the one hand the General Manager's side of the Commission, and in particular Naval Reactors, is responsible for the operation of a nuclear power reactor, and at the same time the Directorate of Regulatory Operations is responsible for the inspection and assurance of compliance with safety requirements for the Beaver Valley plants.

To quote page four of the document and in particular Recommendation Number Four:

> "With specific reference to the Beaver Valley and Shippingport plants the following recommendations are made:
>
> A. The Duquesne Light Company should be made the single accountable authority for both site environmental monitoring and operations management at the Shippingport-Beaver Valley site.
>
> B. The Atomic Energy Commission Directorate of Regulatory Operations should assume the regulatory authority for the Shippingport plant.
>
> The above recommendations will end the duality in operations at the two facilities."

On Page 43 of the Report, the following comments are added:

"The matter of dual occupancy at the site added to the confusion. The Shippingport nuclear steam supply system is owned by the U.S. Atomic Energy Commission, Division of Naval Reactors. The conventional end of the plant, from the turbines on out, is owned by Duquesne Light

> Company. Next door to Shippingport are the BVPS owned by Duquesne Light Company. Duquesne Light Company operates or will operate both facilities. The U.S. Atomic Energy Commission Directorate of Regulatory Operations regulates BVPS, but not Shippingport. This whole scene devolved into a situation where AEC (Regulatory) was unaware of Shippingport activites, Naval Reactors was not interested in BVPS monitoring data, Duquesne Light operations at Shippingport were unaware of the BVPS activities and vice versa. It is clear that much more intra and inter-agency communications is in order. If the principles of apartheid are continued at the site, particularly between the two entities of the AEC, it is possible that the outcome of the next lack of communication will be less innocuous.
>
> For matters affecting the environment it is prudent that all facilities on a reactor site be considered simultaneously, without regard to the licensing status of individual facilities."

I therefore request that you review this particular aspect of the report and solicit your help in cooperation in the implementation of this recommendation. I look forward to your response and welcome the opportunity for further discussion of these vital matters with you.

Sincerely,

Milton J Shapp

MILTON J. SHAPP
Governor

OCT 28 1974

Honorable Charles H. Percy
United States Senate

Dear Senator Percy:

This is in response to your referral of the letter dated October 4, *att.* 1974, from Mr. Ted Falls of Wheeler, Indiana. You asked that we provide the materials to which Mr. Falls referred in his letter.

I understand that the first three items have been sent previously, so they are not included in the enclosed. With regard to the other material about which Mr. Falls inquired, the following are enclosed:

1) The three-volume set of WASH-1258

2) The address of the National Council on Radiation Protection and Measurements

3) The address of the American Academy of Pediatrics

4) A bibliography of printed materials by and about Dr. Ernest J. Sternglass which was compiled at the Oak Ridge National Laboratory, Tennessee

In addition, a number of other questions were listed which I asked the AEC's Office of Plans and Analysis to address. Their remarks, including the referenced WASH 1174, "The Nuclear Industry 1973", are also enclosed and may be of interest to Mr. Falls.

I hope this material will be helpful. We would like to continue to be of assistance in any possible way, so please call upon us if additional information is needed. Mr. Falls' letter is returned as requested.

Sincerely,

Original signed by
N. W. Burr, Jr., M.D.

James L. Liverman, Director
Division of Biomedical and
Environmental Research

bcc: OCR (3) w/o enclosures
AGMB w/o enclosures
MCB w/o enclosures
BP w/o enclosures
OPA w/o enclosures

[illegible] - 20-3

Wheeler, Indiana 46393
October 4, 1974

Hon. Charles Percy,
United States Senate,
R. 4321, Dirksen Senate Office Building,
Washington, D. C. 20510.

Attention Mr. John Pearson

Dear Senator Percy:

As Mr. Pearson was occupied in a hearing, I must express my appreciation for the kind attention given me by Miss Allison Kothe when I visited your office October 1. It is because of her indication of your continued interest in matters of nuclear energy that I am writing this rather detailed letter.

This refers to the paper I sent you on the hazards to the public from day-to-day radioactive emissions, which you sent to the Atomic Energy Commission for evaluation. You kindly sent me the reply of December 4 by Mr. James L. Liverman, without the enclosures he listed. I pursued the references without complete success, but was forced to drop the enterprise about the middle of February because of a continuous flow of assignments from the Izaak Walton League. I hope I have more leisure now to take up the matter again.

Regarding the enclosures that were listed:

* needed TID-4060. This obscure reference has not turned up readily. I may be able to identify it in Nuclear Abstracts, but have not as yet been able to get to the reference library for the purpose. Perhaps you would be able to have a copy sent to me, through the AEC.

needed Statement of President of Health Physics Society. I have not been able to find an address for direct correspondence.

needed Remarks of L. Manning Muntzing, 8/7/73. Dr. Muntzing kindly sent me a copy of this paper.

There were references within the text of Liverman's letter as follows:

p.1.) Final Environmental Statement (Wash-1258). My letter to Dr. Muntzing did not produce this Statement. A print of my letter is enclosed, with his response typed below my signature, and my more recent note.

p. 2.) The National Council on Radiation Protection and Measurements, Report No. 39, is listed at $2.00. I have not found their address in Washington. My letter of inquiry to them to establish their address before placing an order had no reply, nor was it returned by the Post Office.

US Public Health Service. My direct letter has received no reply. My inquiry to the Superintendent of Documents for listings of other material bearing on Dr. Sternglass and nuclear emissions resulted in the reply enclosed.

Dr. Edythalena A. Tompkins. I noted listings of three of her papers in previous research. My direct letter to her came out as in the attached print.

Dr. Jack S. Marshall of Argonne National Laboratory responded to my inquiry with valuable material.

In another direction of discussion of the AEC, I am enclosing three other papers.

The letter of February 13 to Sen. Mike Gravel discusses several issues. At the bottom of page 1, "other points", and through page 2, I have raised another problem with the AEC. Senator Percy might be interested in some of the balance of the discussion.

I went no further with the AEC problem until the Letter To The Times by Roger Robb was sent me. I responded in the same medium. My full text is included. There was reasonable cutting and one forgivable mistake, but the Times gave my letter very considerable space as you can see from the print.

On September 21, I was invited to take part in a panel discussion on nuclear energy at Indiana University Southeast, for which I prepared the paper Nuclear Energy vs. The Public Interest, enclosed. This follows the theme of the Letter To The Times to some extent. Because the time was so sharply limited, this paper does not have the depth, nor the supporting information, that I hold as the standard for my work. However, I hope it may open avenues that will be used by those more expert than myself. This is the first time I have called for a congressional investigation before the public. It is not, however, the last time. I am rather surprised that so much material has come to my attention between the letter of February 13, and the paper of September 21, without specialized research on my part.

There are other questions that are not addressed in these papers.

What is the true cost of nuclear power? The power companies are charged a rate for uranium fuel that makes it highly competitive with all other fuels in spite of the cost of servicing the heavy investment in plant. The AEC produces and refines the uranium, and prepares the fuel rods for installation in the reactor, as well as carrying the extensive and necessary administrative and regulatory expense. No power outside of Congress can exact a true accounting by the AEC. All others interested are given such information as the AEC chooses to release. AEC money is tax money.

What is the true energy balance? Sources that I would prefer to verify before I use their data claim the net energy gain is zero or less. The National Academy of Engineering, in its study US ENERGY PROSPECTS, published about May, 1974, and recently released, claims a net energy gain of about 10%. But this organization is peculiarly the power to exact a full and true audit.

The first runaway reactor that releases so much radioactivity that a city must be evacuated, or a large area of farmland or public park must be abandoned, will result in a public demand that all nuclear reactors be shut down forthwith, permanently. No gloss or blandishment will stem the tide. Can the power companies afford the loss of their investment? Should the taxpayer dredge them out? It is only a matter of time until we must face the issue.

Yours respectfully,

Ted Falls

Ted Falls.

Enclosures:
- Letter to L. Manning Muntzing, 2/8/74
- Letter to Superintendent of Documents, 2/8/74
- Letter to Dr. Edythalena A. Tompkins, 2/8/74, with returned envelope on bottom of print.
- Letter to Sen. Mike Gravel, 2/13/74
- Letters To The Times, Hammond, Ind.
  - Robb, 7/5/74
  - Falls, 7/28/74 (Text)
  - Falls, 8/11/74 (As published)
- Nuclear Energy vs. The Public Interest, 9/21/74.

Copy to Sen. Mike Gravel.

NOV 1 9 1974

Mrs. Calen C. Radle
R. R. 1
Arkansaw, Wisconsin 54721

Dear Mrs. Radle:

Thank you for your letter of November 7 regarding your concern for the building and safe operation of nuclear power plants in the southwest region of Wisconsin.

As you have stated in your letter, many people around the country have been concerned about the safety of nuclear power. This has also been a primary concern of the Atomic Energy Commission and its reactor safety research program, and has resulted in this source of electrical power receiving greater scientific and technical attention than any other form of energy during the past 20 years. During this time the results of this research and related safety analyses have shown that the risks to the public associated with nuclear power are very small.

You may be interested in the results of a two year independent study of nuclear reactor safety directed by Professor Rasmussen of the Massachusetts Institute of Technology which concluded that the likelihood of reactor accidents is much smaller than many types of non-nuclear accidents with similar consequences. A summary release on this study is enclosed.

In a letter of this type, it is not possible to cover all the aspects of the siting and operation of nuclear power plants, reactor safety, radioactive waste disposal, etc. Therefore, I have enclosed a number of relevant reports and brochures which cover these areas of concern for your information. I believe you may also be interested in the remarks of Dr. Dixie Lee Ray, a noted zoologist and Chairman of the U. S. Atomic Energy Commission in her assessment of today's energy situation, and also the report by Dr. Ralph Lapp, a consultant on environmental matters for the U. S. Senate Public Works Committee which provides a "Citizen's Guide to Nuclear Power." The report by Dr. Forbes and his colleagues, who after several years of detailed study have changed their position on the safety of nuclear power and now concluded that for the next quarter of a century nuclear power is the preferable method for generating electricity when compared to all other available sources of power including coal and oil, may be useful in your review of this area.

In regard to land use, you may be interested to know that on an average, for a large (1 million kilowatt) nuclear power plant approximately 200-400 acres of land is normally required. On the other hand, if you were to substitute a comparably sized coal fired plant, it generally requires approximately 1000 acres, including onsite coal storage and ash disposal.

Your point that the Federal government should be encouraged to put more tax money into research on other energy sources such as solar and geothermal and others, has been accepted by this session of the U. S. Congress. The overall Federal budget for energy research has approximately doubled beginning this past July, with a greater emphasis being placed on the development of other energy sources such as coal, solar energy, geothermal and others. In a related development, you may be interested to know that Federal legislation was enacted on October 11 which forms a new Energy Research and Development Administration. In this new legislation the Atomic Energy Commission is abolished and all of its programs are integrated into a new broader based energy organization. All other forms of energy research which had been formerly carried out under the Department of the Interior and the National Science Foundation will now-also become part of this overall organization. In this way it is hoped that all energy sources will receive greater scientific and technical emphasis than in the past and thereby assist the U. S. in developing a degree of self-sufficiency which appears warranted by the recent oil embargo situation.

I hope the enclosed material provides further insight into your concerns regarding nuclear power; if I can be of further assistance do not hesitate to let me know.

Sincerely,

(S)

Walter G. Belter
Senior Environmental Engineer
Division of Biomedical and
Environmental Research

Enclosures

bcc: J. Swinebroad rdg MC #13853

November 7, 1974

.omic Energy Commission
Walter G. Belter
Div. of Biomedical Env. Research
Washington, D.C.

Dear Mr. Belter,

As a Senior Environmental Engineer of the AEC and a native of Eau Claire, Wis., I just recently read in the Eau Claire Leader-Telegram where you received the 1st Fed. Env. Engineer of the Year award. My reason for writing to you today is the subject of Nuclear Power Plants.

You may have read or heard that Northern States Power Co. of Eau Claire is planning to build a Nuclear Power Plant around this area. Their plans at first was to build 2- 1150 megawatt generators with the taking of 4,700 acres of land. They claim now that due to the inflation, their plans are now to delay the first reactor for three years and the second unit indefinetly. According to the AEC, the second unit has been cancelled. NSP have purchased most of the land by threatening the landowners if they weren't going to sell, they would get condemned. Now NSP plans are to rent the land back to the landowners for $10 per acre and anyone outside the plant area for $15 per acre.

Truthfully speaking, I just don't like the idea utilities operate and from what I have been reading and hearing, this also goes for the Atomic Energy Commission.

Could you honestly tell me what your reaction is to building more Nuclear Power Plants and how you fell about the safety of them, the taking of productive farm land, the shutdowns, waste disposal, theft and many others problems associated with its use.

I truthfully feel that we should encourage our federal government to put more of our tax money toward research of other energy sources, like solar energy, wind & tidal power, geothermal and many others that are clean and inexhaustible. I am one of over 100,000 petition signers opposed to the construction of Nuclear Power plants because of the problems and I believe it is time (right now) to dwell on other energy sources.

Northern States Power Co. plans are to get power from the Manitoba Hydro Electric Plant in Canada. I believe in conservation, but if the Wis. Public Service Comm. finds that we are in need for more electricity, I would very much prefer a hydro-electric plant (a study two years ago shows where one had been planned for around this area - I believe by another electrical company) or a coal fired plant with all of its up to date health protectors. I dislike very much the taking of homes & buildings for a generating plant where a clean and safe plant could be put somewhere where this doesn't happen. Building Nuclear Power Plants does take alot of productive farm land, and like it is here, people have to relocate their homes, buildings & land. It has caused the landowners alot of misery., because I know - my parents owned 80 acres of land in the plant site.

Please check into the Nuclear Industry for me and honestly tell me if Nuclear Power is really feasible and economical with all the risks involved. People in Eau [illegible] showing great concern and alarm about such a plant. There are many people opposed to the construction of this plant. There are 4 other utilities planning to build Nuclear Plants at Fort Atkinson, Wis. and a great number of people are opposing it.

Thanking you, I am

Yours truly,
Mrs. [illegible] C. Radle

APR 30 1975

Mrs. Roy L. Lamb
412 Neosho Boulevard
Neosho, Missouri 64850

Dear Mrs. Lamb:

Your letter of March 10, 1975, to President Ford has been referred to this office for reply.

Please be assured that your Government shares your concern over the safety aspects of nuclear power plant operation. The electric utility companies who operate nuclear power plants in the United States are required to meet rigid construction and radiological safety criteria established by the Nuclear Regulatory Commission before they are licensed to build or operate a nuclear power reactor.

The objective of the Energy Research and Development Administration's (ERDA) environmental research and development program is to assure that activities involving nuclear energy and all other forms of energy are conducted with due regard to human health and safety. In order that you may understand the scope of this effort, we are sending you, under separate cover, a copy of TID-4065-R1, "Summaries of USAEC Environmental Research and Development." Although this document was written under the auspices of the former Atomic Energy Commission, the programs described therein are being continued today under the Energy Research and Development Administration.

You will be pleased to know that when ERDA was created under the Energy Reorganization Act of 1974, the Offices of Assistant Administrators for Fossil Energy, Nuclear Energy, and Solar, Geothermal, and Advanced Energy Systems were created. Under

[illegible], HEALTH & SAFETY -20-3

the latter Assistant Administrator, the Divisions of Solar Research and Geothermal Research were established. It is anticipated that funding for research in these two important forms of energy will be in the hundreds of millions of dollars over the next decade.

We appreciate your interest in our Nation's energy problem. If we can assist you further, please let us know.

Sincerely,

Original signed by
W. W. Burr, Jr., M.D.
James L. Liverman, Director
Division of Biomedical and
Environmental Research

bcc: AMF
BER:MCB
J. Liverman, BER
J. Miller, BER
BER:EP rdg file

GM: 04087569

BER:MCB
RCBrothers
4/24/75

ENERGY RESEAR
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APR 7 AM 8 48

412 Neosho Blvd.
Neosho, Missouri, 64850
March 10, 1975

rald R. Ford
esident of the United States
e White House
shington, D. C.

ar Mr. President:

a citizen of this great country, a lover of mankind, and a ther, I urge you to use the power of your office to discourage e proliferation of nuclear power plants. he tremendous potential ngers from mishandling of nuclear waste products and possible harm those who must work with it every day boggle the imagination.

e channeling of U. S. government funds and influence toward the velopment of wind and solar power seems to me the wiser use of our sources. Please, Mr. President, this is not a political question t a matter of life and death, to us now, and more certainly to our ture generations.

ank-you for listening.

Sincerely,

Mrs. Roy L. Lamb

Mrs. Roy L. Lamb

MAY 6 1975

Mr. Jeremiah Scott
1306 South Pershing
Indianapolis, Indiana 46221

Dear Mr. Scott:

This is in response to your letter of March 23, 1975.

Please be assured that your government shares your concern over the safety aspects of nuclear power plant operation. The electric utility companies who operate nuclear power plants in the United States are required to meet rigid construction and radiological safety criteria established by the Nuclear Regulatory Commission before they are licensed to build or operate a nuclear power reactor.

Nuclear reactors are designed to retain all but an extremely small fraction of the fission products formed during the operation of the reactor. Reactor operators are required to continuously monitor the gaseous and liquid effluents released to the environment. The Federal government has established rigid regulations pertaining to the release of such material. These are set forth in Title 10, Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation." I have requested the Nuclear Regulatory Commission, formerly a part of the Atomic Energy Commission (AEC), to send you a copy of 10-CFR-20 for your retention. I am enclosing several publications from our "Understanding the Atom" series. Two of these, "Nuclear Power and the Environment" and "Atomic Power Safety," should give you a better understanding of the safeguards built into a typical reactor and of the procedures followed in the management of radioactive waste material.

I am also enclosing for your retention a draft copy of WASH-1400, "Reactor Safety Study." This is a study sponsored by the former AEC to estimate the risks that could be involved in potential accidents in commercial nuclear power plants. The purpose of the study was to make estimates of the risks involved and then compare them with nonnuclear risks, e.g., motor vehicle, falls, fire, etc., to which individuals in our society are now exposed. Table I on page 2 of the study lists the risk of fatality by various causes including that from nuclear reactor accidents. The study believes that nuclear risks are small, but makes no judgment as to their acceptability.

In addition to the nuclear safety responsibilities imposed upon reactor operators, there are several networks established by both Federal and state governments for the purpose of monitoring the levels of radioactivity in the environment. The Energy Research and Development Administration (formerly the Atomic Energy Commission) maintains surveillance of air, water, milk, and vegetation in the areas surrounding all of the National Laboratories (such as the Holifield National Laboratory in Tennessee and Brookhaven National Laboratory in New York). The Environmental Protection Agency (EPA) maintains an Environmental Radiation Ambient Monitoring System (ERAMS) consisting of 74 sampling stations, 55 of which are on standby if the need arises. The remaining 19 stations collect one or two air filter samples per week. The 74 stations are located in every state plus Puerto Rico and the Canal Zone. A Pasteurized Milk Network, maintained by the EPA, consists of 65 milk sampling stations, 63 located in the United States and one each in Puerto Rico and the Canal Zone. Fifteen states routinely collect milk samples and report their findings to EPA.

The Energy Research and Development Administration has recently created a facility known as the Atmospheric Release Advisory Capability (ARAC). When fully developed, this facility will provide rapid atmospheric and radiation dose information to any one of a number of ERDA installations which might experience an unexpected incident.

I hope the above information plus the material contained in the enclosed publications has answered your questions concerning reactor safety and environmental contamination. If you have further questions, or if we can assist you in any way, please do not hesitate to ask.

Sincerely,

Original signed by
James L. Liverman

James L. Liverman
Assistant Administrator
for Environment and Safety

bcc: J. Miller, BEK
Exec Reg

Enclosures:

MC: 4303

March 23, 1979

James L. Liverman
Assistant General Manger for
Biomedical and Environmental Research
and Safety Programs

Dear Sir;

I am a very concerned citizen who is doing all I can to help out in the energy crisis. I've heard the answer to our limited energy problem is the Atomic Nuclear Reactor. However, there's a haunting question bothering me. How safe is the Atomic Nuclear Reacton ?

I have read there's mounting concern about the dangerous amounts of radioactive materials that will be released into our environment. Contamination from this radioactivity could have a tremendous effect upon american lives today and in future generations to come. Genetic injury is a cause for real concern, not to mention if our foodsource, rivers and soil become contaminated.

We are told that there are a number of radioactive waste products released at reactor sites that do not decay for dozens or even hundreds of years. This means that the accumulation of radioactivity in our environment will increase. It has been pointed out that much of this released radiosotopes tend to concentrate in human and other organic systems, resulting eventually in building up of formidable doses of radionuclide.

In a 1971 survey by the nuclear utilities Services, it was revealed that high levels of radioactivity in the Ohio River bottom sediment rose in parallel to the upsurge of strontium 90 in the soil and milk of that area.

I understand the visions of enormous benefits the reactor could provide for mankind, yet I can't ignore the dangers either. I am neither pessimistic or optimistic concerning the construction of more Atomic Nuclear Reactors. However, I feel a point of view should be taken from the public interest on these matters. Nuclear safety is not only a scientific question, it is a humanitarian, moral and philosophical decision. I would appreciate any information you could supply me on your safety program.

Sincerely yours,

Jeremiah Scott

SEP 4 1975

Mr. William K. Watson
3257 S. 182nd Place
Seattle, Washington 98188

Dear Mr. Watson:

Your letter of June 25, 1975, to the Energy Research and Development Administration has been referred to this office.

The matter over which you express concern is, of course, a serious one, and one in which ERDA is very interested. The report to which you make reference undoubtedly is a paper by C. V. Chester and R. O. Chester in the March 1974 issue of Nuclear Technology entitled "Civil Defense Implication of an LMFBR in a Thermonuclear Target Area." The effects at lower overpressures on an LMFBR were considered in Chapter 18 of a publication from the Oak Ridge National Laboratory, Civil Defense Research Project Annual Progress Report, December 1972. This document is available from the U. S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22151. Price: Printed Copy $3.00; Microfiche $0.95.

The effects of nuclear weapons on various types of reactors are under continuing research, and results are published as they become available. The journal of Nuclear Safety usually has references to this work.

Analyses to date indicate that if a nuclear weapon explodes on the containment building of a light water reactor (LWR), the core will be exposed and crushed (although for intermediate size weapons not vaporized), and mixed with other crater debris. For low-yield weapon explosions, the reactor core would remain in fairly large pieces and will not be distributed as widely as the radioactive fallout from the weapon itself.

There are many factors which a country with a limited stock supply of nuclear weapons might consider before embarking on the course suggested in your letter. The effectiveness and consequences of such an action are highly questionable. For example, if the intent is to destroy a nation's armed forces, it would be preferable to direct the weapon against a military target rather than against a reactor where release of the core materials might, in sufficient quantities and form, and with proper distribution, result in health consequences decades later, and would have little immediate effect--other than loss of power--on a war effort. On the basis of economic, strategic, political and military considerations, a reactor does not appear to be a high priority target for the purposes you suggest.

Plutonium dioxide is one of the most refractory substances known, and will not be vaporized from the core fragments to any appreciable extent. The lethal effects of the volatile and semivolatile fission products could be expected to cover a much larger area than any carcinogenic effects of the comparatively limited number of fine particles of plutonium produced in the destruction of the core. The area covered by lethal levels of radioactive fallout from the weapon itself will be many times larger again.

As shown in Table 4-28 (p. 4-75) of WASH-1250, 0.027 kg of plutonium-239 per ton of spent light water reactor fuel would be found in the high-level wastes produced during fuel reprocessing (1/6 to 1/3 of the core would be reprocessed annually). With plutonium recycle the bulk of the plutonium-239 produced in a LWR power plant would be used in mixed oxide fuel and then converted into electricity in other nuclear power plants, as discussed in WASH-1250 (e.g., p. 4-91). There would be roughly 0.13 kg of plutonium-239 per ton of spent LWR fuel in alpha wastes produced during fuel reprocessing and fabrication operations.

The estimate of lung cancers is extremely dependent upon the acceptance of highly questionable assumptions (e.g., that a pound of plutonium will be divided exclusively into uniform dimension particles of respirable size; that material will remain pure plutonium dioxide and not combine with uranium, fission products and inert materials; that this material will be uniformly dispersed on land area but not the oceans; that Dr. Geesaman's hypothesis is in fact true; etc.). Each of these points is very hypothetical, and there has been considerable discussion concerning the Geesaman hypothesis.

We would suggest that you consult other sources of information on the topic of plutonium toxicity, some of which discuss the Geesaman hypothesis and the basis for it. These documents include:

might add — The remainder of the
plutonium produced would, of course,
[illegible] power plants.
used as

WASH-1535, Proposed Final Environmental Statement, Liquid Metal Fast Breeder Reactor Program, Vol. II., Section 4.7 and Appendix II.G., U. S. Atomic Energy Commission, December 1974. Available from: U. S. Government Printing Office, Washington, D. C. 20402.

ORP/CSD-75-1, Proceedings of Public Hearings: Plutonium and the Other Transuranium Elements, Vol. 1, U. S. Environmental Protection Agency, 1974. Available from: U. S. Environmental Protection Agency, Office of Radiation Programs, Criteria and Standards Division, Washington, D. C. 20460.

WASH-1359, Plutonium and Other Transuranium Elements: Sources, Environmental Distribution and Biomedical Effects, U. S. Atomic Energy Commission, December 1974. Available from: National Technical Information Service, U. S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22151.

WASH-1320, A Radiobiological Assessment of the Spatial Distribution of Radiation Dose from Inhaled Plutonium, U. S. Atomic Energy Commission, September 1974. Available from: U. S. Government Printing Office, Washington, D. C. 20402.

The Toxicity of Plutonium, Medical Research Council, London, 1975. Available from: Her Majesty's Stationery Office, 49 High Holborn, London WC1V, 6HB, England.

LA-5810-MS, A Review of the Natural Resources Defense Council Petition Concerning Limits for Insoluble Alpha Emitters, Los Alamos Scientific Laboratory, November 1974. Available from: National Technical Information Service, U. S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22151.

NRPB-R29, Radiological Problems in the Protection of Persons Exposed to Plutonium, National Radiological Protection Board, Harwell, Didcot, England, September 1974. Available from: Her Majesty's Stationery Office, 49 High Holborn, London WC1V, 6HB, England.

One can hypothesize the number of immediate deaths resulting from uniform optimal dispersal of other materials, such as a pound of botulinus toxin, nerve gas, certain viruses, etc. There is enough water on earth to drown every person. Although such examples are dramatic in terms of the casualties, experience tells us they are unreasonable.

An example of how much atmospherically dispersed plutonium ultimately reaches man is given in WASH-1359 (Table XI, p. 281) referred to above. Hundreds of kilocuries of plutonium were injected into the atmosphere as a result of nuclear weapons testing. Of this amount approximately 10^{-8} has reached man, or about 10^{-17} per person; these numbers are consistent with actual measurements of plutonium in tissue.

If the actual threat and dangers of sabotage to a nuclear power plant were much greater than are presently projected, the plant could be built underground. It is doubtful that a small or medium yield nuclear weapon detonated on a reprocessing plant would have effects greater than those of the weapon itself since the plant would contain in process a limited amount of radioactivity, typically the equivalent of a fraction of one reactor core that has cooled for six months or longer. The potential hazard from wastes stored on site depends on their quantity and the method of storage. Most of the inventory of waste products at the reprocessing plant would be in the high level liquid waste storage tanks, which are already underground. There appears to be no need to locate the remainder of the fuel reprocessing plant underground.

At the present time there is no power reactor fuel being reprocessed commercially in the United States. The subject of waste management is under consideration by the responsible divisions of both the Nuclear Regulatory Commission and ERDA. Waste management methods being considered would not add materially to our vulnerability to acts of war.

I hope that this information provides some perspective on your expressed concerns.

Sincerely,

Original signed by
F. W. Burr, Jr., M.D.

James L. Liverman, Director
Division of Biomedical and
Environmental Research

bcc: Dr. Liverman

MC 8368

June 25, 1975

Energy Research & Development Administration
Washington, D.C.

I would like a reference to a report prepared by a team of qualified experts which discusses the foreseeable consequences of a small yield nuclear device impacting directly on the nuclear core containment building of a 1,000 Megawatt LWR or breeder reactor after it has developed its normal radioactive burden; a report which covers the foreseeable consequences over the period - years, dedades, centuries, milleniums - when the radioactive products dispersed by such an event could be expected to remain biologically active.

(Why do I think such an event might happen? A large power plant represents a tempting military target. A large nuclear power plant is a doubly tempting target for a country with a limited nuclear arsenal, because such a plant can amplify the radiological effect of a small nuclear device hundreds of times, and particularly if meteorological conditions are chosen with care these radiological effects can produce far more devastation than the predictable effects of suddenly cutting off 1,000 Megawatts of electricity. There are predictions that some 50 countries will have the Plutonium 239 from nuclear power plants they need to build small nuclear devices, by the end of the century.)

I am particularly interested in what would happen to the 1,000 lbs or so of Plutonium 239 which would be part of the normal radioactive burden of a 1,000 Megawatt LWR power plant. (AEC WASH-1250 contains an estimate that there will be about 6 Kg of Plutonium 239 per ton of fuel in such a plant, and states elsewhere that some plants have in excess of 150 tons of fuel in place in the core.) The breeder reactor will, I believe, have much greater amounts of Plutonium 239 in situ.

What probability is there that in the nuclear destruction of a 1,000 Megawatt nuclear power plant by a small nuclear device that the Plutonium 239 in the plant core would be vaporized and then condense in the form of an aerosol of fine, insoluble particles averaging 1 micron size, as hypothesized by Dr. John Gofman in predicting that in this way a single pound of Plutonium 239 could create some 3 billion effective human lung cancer doses on the basis of a Dr. Geesaman's estimate that there will be one human lung cancer induced for each 10,000 fine particles of Plutonium 239 inhaled into the lungs?

If such an aerosol of fine particles of Plutonium 239 is a possible result of a small nuclear device impacting a 1,000 Megawatt power plant, how many actual cases of human and animal lung cancer could be predicted for each pound of Plutonium 239 injected into the atmosphere in the form of an aerosol of 1 micron particles, over the period of time before this material could be predicted to represent no further threat, primarily by being swept by normal atmoshpheric washing processes into the depths of the oceans?

Is it not true that this danger could be eliminated for all practical purposes by requiring that the nuclear core of an atomic power plant be located at least 200 ft underground, as has been recommended by Dr. Edward Teller on many occasions? Would a small or medium yield nuclear weapon dropped on a reprocessing plant for nuclear wastes produce even more serious radiological problems, so that it might be wise to locate them underground also?

This letter represents my fourth attempt to secure information about such an event. (Three previous inquiries were made to the AEC.) I am hoping that as a new administrative agency taking over from the AEC you will be willing to make some kind of response, even if it is to say you have no intention of going into the matter. (No answer of any kind was given to my previous letters.) Please? Some kind of answer?

Very truly yours,

William K. Watson

William K. Watson
3257 S. 182nd Pl.
Seattle, WA 98188

Note: Dr. Gofman's comments about the possible cancerous properties of a fine dispersion of a pound of Plutonium 239 can be found on page 7 of "The Case for a Nuclear Moratorium" published by the Environmental Action Foundation, Suite 724, The Dupont Circle Bldg., Washington, D.C. 20036. Price $1.50. The figure of 3 billion potential cancer doses is deriveable as follows: One pound of Plutonium 239 as a solid occupies about 28 cm^3. A cm^3 divided into one micron particles would number 10^{12} particles. If one accepts Dr. Geesaman's estimate of one human lung cancer for each 10^4 particles inhaled, then one pound of Plutonium 239 in the form of 1 micron particles would equal about 28 cm^3 x 10^{12} particles/cm^3 x 10^{-4} cancer doses/particle = 2.8×10^9 cancer doses, or about 3 billion potential cancer doses from each pound of Plutonium 239 turned into 1 micron particles. Since there are about 5×10^{14} square meters on the face of the earth, the even dispersion of 1,000 lbs of Plutonium in the form of 1 micron particles over the face of the earth would distribute about $1{,}000 \times 2.8 \times 10^9$ doses over 5×10^{14} m^2 = about 180 square meters per 10,000 particle dose. In a population of 200,000,000 in the area of the US, do you have an estimate of how many Plutonium particles would end up in human lungs in the course of an average year, in the form of dust particles stirred up from the earth's surface, given this density of distribution of particles of Pu 239?

AES/Ki
Mr. Maher

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

SEP 8 1975

Honorable William M. Ketchum — Holbate H 9/13/75
House of Representatives

Dear Mr. Ketchum:

The Energy Research and Development Administration (ERDA) staff has reviewed the letter from your constituents, regarding the nuclear power plant proposed for construction in Wasco, California, as you requested in your August 19, 1975 letter to Dr. Robert C. Seamans, Jr., Administrator of ERDA. The following comments are offered for your use in replying to their letter.

The plant referred to is commonly called the proposed San Joaquin Nuclear Project (4-1300 megawatt units), to be owned by the Los Angeles Department of Water, the Pacific Gas and Electric Company, the Southern California Edison Company and the San Diego Gas and Electric Company. ERDA does not have information to answer such questions as the need for power in Kern County, the direct economic benefits of the proposed plant, sources of cooling water for the plant and jobs to be provided due to the location of the proposed plant in Kern County. These factors will be considered by the utilities in their environmental report to be submitted to the Nuclear Regulatory Commission (NRC). NRC will evaluate these and other factors in the process of preparing an Environmental Impact Statement for the proposed plant. We understand from NRC that the utilities have submitted an Early Site Review Report for the proposed plant. NRC is now evaluating this report and the proposed plant site, with emphasis on the geology, hydrology and seismology of the area. Information concerning this early site review is on file at the NRC public document room located in Bakersfield, California. We also understand that additional information is available in the Draft Environmental Impact Report for the San Joaquin Nuclear Plant that was submitted by the utilities to the State of California, as required by California law.

The following information is provided in response to the more general questions regarding nuclear power. All civilian nuclear power reactors must undergo an extensive safety review by the NRC. Through a defense in depth approach, the risk of a reactor accident is reduced to acceptable levels. It should be noted that no member of the general

[illegible]

public has been killed or injured as a result of a reactor accident. ERDA is studying retrievable surface storage of transuranic and solidified high-level wastes (primarily from reprocessing of spent fuel) as an interim measure, pending further evaluation of permanent disposal concepts. The evaluation of promising geological formations and sites leading to a pilot geological repository, which in turn could lead to a permanent disposal system, is a major part of the ERDA radioactive waste program. At present, ERDA plans further study of several promising geologic formations other than bedded salt, including study of specific promising sites, to bring the state of knowledge of these other formations up to the same level as that of bedded salt. The goal of this further study is to permit a comparative evaluation of these formations and the selection of the optimum formation or formations for pilot plant operations. Following successful pilot plant operation, a disposal facility for high level waste would be developed and then used for high level wastes from the nuclear industry.

Steps are underway to improve emergency plans for all nuclear accidents, including accidents in transit. A training program in "Radiological Emergency Response Planning" for State and local government emergency planning personnel has been established at the Defense Civil Preparedness Agency (DCPA) Staff College in Battle Creek, Michigan by the NRC and other involved Federal agencies (a Federal Interagency group). Approximately 50 State and local government emergency planning personnel have already attended this one-week course. In addition to the formal training and guidance provided by NRC and other involved Federal agencies, the Federal Interagency group provides field assistance in radiological emergency response plan development and improvement directly to the States upon their request. This is accomplished via a "Federal Interagency Field Training Cadre." Most States now have active programs underway to improve their radiological emergency response posture and plans. The NRC, and other involved Federal agencies, recognize that certain improvements need to be made in State and local government radiological emergency response plans. By virtue of these activities, the NRC is actively pursuing a multi-faceted program of providing guidance, assistance and training to State and local governments. Research and development efforts on several aspects of these problems are underway at several of the National Laboratories and by the NRC and ERDA headquarters staffs. Examples include the Atmospheric Release Advisory Capability (ARAC) at the Lawrence Livermore Laboratory, the Clinch Valley Study at the Holifield National Laboratory, and a rapid version of the Aerial Radiation Monitoring System (ARMS) being considered for development by the headquarters staffs.

It is expected that low-level radioactive wastes from the proposed power plant will be shipped, by truck or rail, to existing or future commercial radioactive waste burial grounds. Although these wastes are carefully packaged to prevent releases in accidents, such wastes would not be useful for any terrorist activities and thus no special security measures are used for such shipments. Measures to be taken to prevent theft or sabotage of nuclear materials are discussed in Section 7.4, Volume IV, of the Liquid Metal Fast Breeder Reactor (LMFBR) Program Proposed Final Environmental Statement (WASH-1535), a copy of which is enclosed.

Regarding releases of radioactivity to the environment from nuclear power plants, operating experience to date has shown that doses of radiation to the population from such releases are only a small fraction of those allowed by standards or of doses due to natural radiation or medical exposures. We also agree, of course, that nuclear power should be produced safely and without damage to the environment. We feel that this can be accomplished with technology already existing or under development.

We trust that this information will be useful in answering the questions of your constituents. If additional information concerning nuclear power is required, we would be pleased to provide it.

Sincerely,

Original Signed by
T. A. Nemzek
T. A. Nemzek, Director
Division of Reactor Research
and Development

Enclosures:
1. Volume IV, Proposed
   Final Environmental Statement,
   LMFBR Program (WASH-1535)
2. Letter from constituents

Dear Representative Ketchum,

We are a group of people living and working in the Bakersfield area, concerned about the problem of nuclear generated energy. We are concerned mainly that our public servants, as well as our fellow citizens, are not aware of all currently available information dealing with nuclear power. It is our belief that decisions about nuclear power are being made in this country without thorough consideration of all the facts. The facts suggest that nuclear power use has far ranging consequences to our environment.

The Board of Supervisors of Kern County recently endorsed the philosophy of an organization called KEEP, concerning the proposed Wasco Power Plant (Californian, July 16). The leaders of KEEP feel that the proposed plant should be built if their five principles are met. We feel that the guidelines, as they were presented and accepted, are too vague to be workable. We think that they deal with economic and energy needs much more than with environmental safety.

We would like to pose some questions that we feel have not been answered adequately and that must be answered before the proposed plant can be built. We do not believe in scare tactics. We want objective, rational consideration of all the facts before a decision is made.

KEEP's first guideline is that the plant provide needed power for Kern County. We would ask: how much power will Kern County receive from the plant? Has an assessment been made of our future energy needs? Do we have alternate, safer sources of power that are not now being used? We recognize the need to develop sources of energy in order to maintain our current standard of living. But, perhaps the gravity of the energy crisis is a warning that we need to slow down in our consumption of energy. Our resources are limited and it is time we realize this.

KEEP's second principle is that the nuclear plant will provide jobs to better Kern economy. Will the fact that we have a nuclear power plant in Kern County insure that we will also have more jobs? Do more jobs mean a better economy? A more basic question to consider is can we afford to increase the population of Kern County and put bigger strains on the environment? Man has changed this desert into an agricultural area which puts an automatic strain on the environment. The system cannot maintain itself naturally. We have great water needs in order to keep the system going. What will increased population and increased growth do to this system? These questions are not being answered that we can see and they must be before this proposed plant is decided upon.

KEEP members urge that the plant, if built, operate without water available for Kern County agriculture and that agricultural waste water be utilized by the plant. Tremendous amounts of water are needed to dissipate the heat from nuclear reactors. Where will this water come from? Are we assured that the plant can operate without agricultural water? What are the plans and what are the energy costs of using waste water for the plant? Water plays a critical part in our agricultural economy. We are putting increasing demands on this resource by our continued growth. Where is all this water going to come from?

There is a wealth of data in the scientific community that points clearly to the fact that the present technology for generating nuclear power and disposing of nuclear waste has grave drawbacks for the environment. There is the real problem of possible contamination by nuclear accident. Are we willing to accept the responsibility for a nuclear accident? No amount of safeguards can guarrantee that there will not be one , and an accident in this area could destroy agriculture for an indefinite period.

Nuclear reactors feed radiation into our environment. The Council on Environmental Quality has stated that doses of radiation to the population are increasing due to nuclear power plant waste. The A.E.C. concedes that any amount of radiation will cause some measure of harm. We cannot ignore the long range implications this type of information suggests.

At the present time there are no nuclear waste processing plants operable in this country. What do we do with the waste? Nuclear waste has a half-life of from 22,400 to 24,000 years. We now store it in containers that are good for only 50-100 years. What happens then? How do we handle the waste from 100 or more power plants? By building more power plants we are compounding problems for which we have no solutions. This is illogical and irrational thinking.

There are other questions we need to ask ourselves. Where will the waste from our plant be stored? How will it be transported and what are the safeguards for this transferral? What are the civil defense guidelines in case of an accident in transit? Have adequate measures been taken to prevent theft or sabotage of nuclear materials? We cannot sit back and assume that someone else has answers to these questions. We must answer them ourselves, critically, before we are put in a position where our speculations become reality.

It is interesting to note that four of the five principles of KEEP deal with economic concerns. Only one principle shows any concern for the environment. We agree that nuclear power should be produced safely and without damage to the environment. But we cannot see that this is possible with the present state of our technology. Logically, we should not use nuclear power for short term energy needs (25-50 years) when we cannot adequately assess the long-range effects on our environment. KEEP sets no guidelines for what is safe and not damaging. We cannot meet standards that are not defined.

The concern of KEEP seems to be basically an economic one. More energy means more economic growth and expansion. It may be time, however, to take a look at this concern critically. We must realize that unlimited economic growth is impossible to maintain, that we must reorient our thinking and redefine our values. We are in a position to make rational and real changes in our ways of life and thinking. If we do not make the choices ourselves they will be made for us. Man is not necessary to the survival of the planet, but the planet is necessary to the survival of man. We should think long and hard before tampering with the environment any more than we have. We do not want to be forecasters of doom and destruction, but we do feel that the building of the proposed nuclear power plant raises many questions with far-reaching implications.

These questions can't be answered adequately, therefore we need to proceed with extreme caution. There are too many unknowns involved in nuclear generated power and we are not now in a position to control or handle the consequences.

OCT 16 1975

INCOMING
NOT IN FILE
MRB 3/17/78.

Honorable Strom Thurmond
United States Senate

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Dear Senator Thurmond:

Your letter to Mr. H. Hollister Cantus dated September 10, 1975, enclosing a copy of a letter from your constituent, Mr. C. G. Andrus, has been referred to me for reply.

The following information is provided as a basis for your reply to Mr. Andrus.

At installations at which radioactive materials are used, appropriate procedures are being followed to maintain levels of concentration of radioactive atmospheric pollutants substantially below that which would cause harm to persons or damage to property. This is true for even the most severe atmospheric conditions of stagnation. These procedures are based on considerable research results.

At the Savannah River Plant during this fiscal year (FY 76), the Division of Biomedical and Environmental Research of the Energy Research and Development Administration (ERDA) is spending well over $2 million to support meteorologists and other environmental scientists in programs designed to lead to a better understanding of what happens during potential releases to the atmosphere. Comparable efforts by other groups are also in progress. Thus, a serious program in environmental science, including meteorology, is being pursued involving millions of dollars annually to provide know-how and information for protecting the public.

Since Mr. Andrus is a meteorologist, it no doubt will be of interest to him to learn that at the Savannah River site there are seven 200-foot meteorological towers and over 30 ground-based stations, which are used to study the environmental conditions related to this problem. Further, before the issuance of a permit to operate a reactor, at least one year of data on wind and stability must be obtained and associated calculations of atmospheric concentrations must be made. Thus, each of the nuclear

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facilities must have meteorological installations with towers to provide the necessary input for both safety analysis reports and environmental impact statements. Examination of these statements may be made by the public in public reading rooms. One exists at the Savannah River Plant.

The Office of Public Affairs of ERDA issues periodic reports that keep the public informed on the operations involving nuclear fuels. Mr. David M. Peek, Assistant Manager for Public Affairs of ERDA at the Savannah River Operations Office, informs us that since the first of the year, 20 press releases have been made concerning nuclear operations in the South Carolina area. These amount to about two per month. Thus, a conscientious attempt is being made to keep the public informed on what is going on and to point out that the probability of hazard to health or damage to property is so extremely low, that for all practical purposes, deleterious effects are insignificant.

I hope that you find the information contained in this letter helpful in preparing your reply to Mr. Andrus. Your correspondence is returned as requested.

Sincerely,

Original signed by
James L. Liverman

James L. Liverman, Director
Division of Biomedical and
Environmental Research

Enclosure:
As stated

bcc: AMF
OCR (2)
BER:MCB
H. Moses, BER
BER:EP Reading File

BER:MCB
RCBrothers
10/9/75

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MC: 09187538

FEB 17 1976

Mr. George F. Murphy, Jr.
Executive Director
Joint Committee on Atomic Energy
Congress of the United States

Dear Mr. Murphy:

In reply to your letter of December 26, concerning the issues raised by Dr. Helen Caldicott in her letter to Senator Pastore, we share her concern about health hazards that are associated with human exposure to mutagenic and carcinogenic agents, of which ionizing radiation is one. For this reason, the Atomic Energy Commission supported a strong research effort on these questions as they relate to ionizing radiation. These efforts have been continued in the Energy Research and Development Administration (ERDA) and have been expanded to include health hazards associated with other energy technologies.

The basic data generated by these studies, together with data from other sources, have been used by scientific bodies that are involved in providing guidance on radiation exposures. These reviewing bodies include the International Commission on Radiological Protection (ICRP), which was formed in 1928, the United Nations Scientific Committee on the Effects of Atomic Radiations, and the National Council on Radiation Protection and Measurements. The U.S. National Academy of Sciences-National Research Council has also set up committees to review these matters: the Committee on the Biological Effects of Atomic Radiations (BEAR Committee) that reported in 1956, and the Committee on the Biological Effects of Ionizing Radiations (BEIR Committee) that reported in 1972, and continues to be active.

At first, when the ICRP was founded, concerns were for the welfare of radiation workers; but over the years concern has broadened to include the health of nonoccupationally exposed people as our understanding of the biological effects of low-level radiation exposure has improved. Concern was broadened by the 1956 BEAR Report which introduced the concept of regulation of the overall average whole-body dose to the population. In 1960, the Federal Radiation Council (FRC) recommended that exposure to radiation should be reduced to a level "as low as practicable," but in no case to exceed 170 millirem per year as the population average.

In 1972, the Atomic Energy Commission held hearings seeking to define "as low as practicable" in its modification of the regulations dealing with the licensing of production and utilization facilities (now Rules and Regulations of the U.S. Nuclear Regulatory Commission), contained in the Code of Federal Regulations, title 10, part 50. It should be pointed out that over the years, since FRC introduced the guides to radiation exposure, the net effect of research was to indicate that the effects of low-level exposures were smaller than we had believed in the period through 1960. Hence, it was the technological feasibility rather than increased estimates of health hazards that dictated the policy now followed by the Nuclear Regulatory Commission of keeping radioactive releases "as low as reasonably achievable," as well as within the environmental concentration guides.

Radiation limits for the population have been based upon considerations that include possible effects upon children, and the National Council on Radiation Protection and Measurements has recommended that exposures of fertile women who are radiation workers be controlled in such a way that the fetus could not possibly receive a significant exposure should one of these workers become pregnant.

Actual exposures of the general population from the operation of nuclear power plants fall far below the level of 1 millirem per year at present and are not expected to reach that level even in the year 2000, assuming the full number of projected nuclear power plants become operative on schedule. By far the greatest portion of man-made radiation exposure of the U.S. population arises from medical diagnostic exposures, amounting to about 95 percent of the total, while exposure from nuclear power stations is a very small fraction of 1 percent (< 0.1 percent). In addition, a somewhat larger source of exposure--natural radiation--comes from radionuclides present in nature and from cosmic particles.

Our society has the very complex problem of weighing risks against benefits for each of the energy alternatives, including the alternative of no energy development. While we know much more about radiation hazards than we do about the hazards associated with, for example, fossil fuel utilization, by no means should one conclude that it is radiation hazards that are the greater. No energy technology has yet been developed to the point of economic feasibility that is totally without such health hazards as those of inducing genetic damage and cancer. Furthermore, the substitution of one form of technology for another may affect health risks in a variety of ways, possibly reducing some risks while increasing others.

FEB 17 1976

Finally, the risks of increased incidence of mutation have been estimated by the BEIR Report. This authoritative report stated that the increases in recessive genetic diseases (of which cystic fibrosis is one example) from exposures more than two orders of magnitude greater than those expected even by the year 2000 from nuclear power plants, would, in the first generation, be "very few." At equilibrium, reached after many generations, these would show only a "very slow increase." However, a disease with the relatively high incidence of cystic fibrosis may very well be maintained in the population by factors other than recurrent mutation, in which case changes in the mutation rate would have even less effect on disease incidence.

Should you require additional information regarding the above, please let me know.

Sincerely,

Original signed by
James L. Liverman
James L. Liverman
Assistant Administrator for
Environment and Safety

bcc: AMF
OCR (2)
DA
EAA
AES
MCB
BP
OS

The Children's Hospital Medical Center

300 Longwood Avenue, Boston, Massachusetts 02115, Telephone: (617) 734-6000

November 24, 1975

Senator John Pastore
Senate Office Building
Washington, D.C.

Dear Senator Pastore:

I am a pediatrician practicing in the Cystic Fibrosis Clinic at The Children's Hospital Medical Center in Boston. I am currently involved in the therapeutic care and clinical research of these children who suffer from an inherited fatal disease of childhood.

I am writing this letter because I am extremely concerned about the medical threat of nuclear power plants, particularly to unborn babies and young children. Inevitable contamination of the environment by radiation, which has already occured, will lead to an increased incidence of inherited diseases like cystic fibrosis. There are approximately 1,000 such inherited diseases and 6% of all babies born at the present time have some inherited defect. We can also expect an increase in the incidence of luekemia and cancer in children and young adults. These effects of radiation are well known to all doctors and are documented throughout medical literature.

Nuclear power poses a great public health problem and because children are more sensitive to radiation than adults, this issue is an integral component of child health. It is vitally important that any decisions involving the development of nuclear power are made with a full knowledge of the medical implications of radiation, both to this and to future generations.

As a practicing pediatrician I cannot understand the present situation when we as doctors are striving to discover the cause and cure of cancer and inherited disease while the government and nuclear industry are proceeding with a policy which will inevitably produce an increase in these diseases.

I therefore ask that I be given an opportunity to present this vitally important complication of nuclear power either to you personally or to the Joint Committee of Atomic Energy, before decisions are made which will jeopardize the future health of mankind.

Yours sincerely,

Helen Caldicott, M.D.

MAR 3 1976

Honorable Lowell P. Weicker, Jr.
Committee on Commerce
United States Senate

Dear Senator Weicker:

Your letter of February 10, 1976, to Dr. Robert C. Seamans, Jr., has been referred to this office for reply. Thank you for giving us an opportunity to comment on the letter to you from Mr. John Paskavitch. He makes several points, which we will discuss in order.

First, he includes an article entitled "Northeast Utilities Report Shows Radiation Increase." We find no fault with this article, and little to be concerned about. Percentagewise, there has been a rather large increase in radioactivity as the nuclear complex has come "on the line." However, the percentage increase is large only because the initial amounts were so low. Everyone agrees that the amounts are within "safe Federal guidelines" and are being carefully monitored. I wish we had such reassuring data on other sources of pollution!

The second article, on the blackfish with a growth on its jaws, likewise, strikes us as being factual and not alarming. In short, we agree with Dr. Wolke--fish are very susceptible both to cancer and parasites.

The third article, Jack Anderson's column, we have seen before. Dr. Vaughan Bowen has been a valued contractor to Atomic Energy Commission/Energy Research and Development Administration for about 23 years, and is one of our experts on radioactivity in the ocean. Dr. Bowen has told me that he wrote to Jack Anderson complaining of the improper interpretation of his data. Of course, his letter of complaint was not published.

The fourth article, by Mr. Paskavitch, is an appeal to close down all nuclear power plants because they release small quantities of radionuclides to the ocean. AEC/ERDA has spent close to $1.5 billion studying the biomedical and environmental effects of radioactivity. In 1973, the National Academy of Sciences published a book entitled "Radioactivity in the Marine Environments." These experts, from throughout the world, reached a conclusion different from that of Mr. Paskavitch.

[illegible] HEALTH & SAFETY - 3-1

I find Mr. Paskavitch's letter alarming. He states that "no one can prove to me that the blackfish didn't get the cancer from atomic poisons." Probably no one can, but there is certainly no evidence that the cancer was caused by radiation. I hope the public who listen to his "fish story" understand that the experts are less convinced than Mr. Paskavitch of the cause and effect of cancer in fish. Marine waters (and particularly freshwaters) are much lower in background radiation than the land on which we humans must live. If radiation were the responsible agent, then cancer in fish should be very low--but it is not.

We will not comment on the portions of the letter addressed to Mr. Anders (NRC) and Mr. Train (EPA).

I trust these comments will be useful in formulating your reply to Mr. Paskavitch.

Sincerely,

Original signed by
W. W. Burr, Jr., M.D.

James L. Liverman, Director
Division of Biomedical and
Environmental Research

bcc: EP Reading File
OCR (2)
AMF
MCB

BER:MCB

OCR R. Gantz
MC 02127629

BROOKLYN TENNIS CLUB AND SKI AREA
R.F.D. Church Street, Brooklyn, Conn. 06234
Tel.: 203-774-5937
JOHN PASKAVITCH, JR.
("Big Time Pasky")
Owner and Operator

Jan. 11, 1976

[illegible]eicker, Jr
[illegible] Senate Office Bldg
[illegible]ngton D.C. 20510

[illegible] Senator Weicker:

Your Jan. News [illegible] triggered this letter. I'm writing a book on a
sh story and it will be the biggest fish story ever told. It starts off
th a fish. "Strange Sight" and ends up with a fish, a 3'x4' blown-up
int of Joe Salonia and the Cancerous black fish. I was there when
e caught it. I rushed him to the Westerly Sun for the news item,
e picture made TV and the Hartford Times. He rushed the fish to
ay Dunn, Mystic Aquarium Naturalist and he said it also had
ncer in the belley. Two weeks later Joe brought in a bluefish
d it had a ugly black hole in its side. We left it with Mr. Dunn.

I have presented my fish story to over 1500 people face to face
nce the past month. The Danielson and Willimantic Chamber of Commerce
s ask me to give my 10 minute talk on the three immediate
ngers facing mankind. Nuclear Radiatition, chemical poisons and
dical Radiation.

The enclosed reprints shows the Radionuclide problem. No one
s prove to me that the Blackfish didn't get the cancer from
omic poisons. Mr. William A. Anders will not tell me how much
90, Sr 89, I 131, and C 137 is in 3 fishes. Bluefish, flounders and
riped bass. By law he must tell me. He doesn't so I'm seeking
citizens arrest because of his unconstitutional and criminal
havior. Please arrange a confrontation for me with Mr. Anders.
have a lot of questions to ask him.

Now let us take a look at Mr. Russell Train. Long Island
und and Conn. River fish are no longer fit to eat because of
CB. The 5 ppm permissible level has reached 1000 in Hudson River
[illegible] and fish swim. The Hudson River is the spawning grounds for
riped bass which is New England favorite game fish. When
enhower warned us to beware the industrial-military complex,
and Thank God it came from a Republican.

Medical Radiation Pollution is the next big national scandal.
Medical Industry under the AMA says the breast X-ray for
cer detection is 100-1. The National Cancer Institute says its
1. I will have [illegible] the 1 in the AMA projection.

Please help to stop this race to the abyss.

Sincerely,
John Paskavitch

APR 14 1976

Honorable Daniel K. Inouye
United States Senate

Dear Senator Inouye:

Your letter of March 23, 1976, to Dr. Robert C. Seamans, Jr., requesting a copy of proposed rules and regulations concerning mental health evaluations of employees working in nuclear facilities has been referred to me for reply.

At the present time, ERDA has no proposed rules or regulations relating to mental health evaluations of employees working in nuclear power plants or other similar facilities.

ERDA operates a rather sophisticated occupational medical program that provides close onsite surveillance of the physical and mental health of employees working in its nuclear facilities. This program provides periodic comprehensive health examinations either annually or biennially, depending upon the employee's age and work assignment. Also, ERDA occupational health physicians maintain an unusually close rapport and integration with management, firstline supervision, other employee health protection disciplines, such as health physics and industrial hygiene, and with the employees themselves. They have the opportunity to see employees at the earliest development of work performance decrement, signs or symptoms of mental or emotional instability or stress, or employee health complaints. Special attention is given to areas such as alcohol, drug abuse, and mental hygiene. The medical staff of our various occupational medical departments maintain an open door policy with respect to being available to consult with employees or to provide counseling. The ERDA physicians also maintain close rapport and communication with employees' private physicians. Through this Occupational Medical Program, we believe ERDA is in an excellent position to detect early onset of employee mental or emotional problems, to determine the need for referral for psychological or psychiatric diagnosis or treatment, and to protect both the individual employee and the security and safety of the nuclear operation, by arranging for temporary work limitations or reassignment to less critical duties. We feel that this approach is more valuable than random or periodic, formal psychological screening tests.

ERDA is in the process of evaluating and validating a sophisticated psychological screening test for its personnel assurance program employees. These are employees with critical work assignments in our nuclear weapons program. This evaluation is being done on a volunteer basis. If it proves to be a valid and valuable selection tool, ERDA may consider applying it to the selection of new candidates for personnel assurance program jobs. At none of our nuclear facilities psychologists are on the occupational medical department staffs. Any psychological testing carried out is done on a voluntary basis rather than on the basis of a strict requirement.

We feel that we have done a good job in this difficult area of employee mental health, and we think ERDA's experience has been quite good. We are not closed to the idea of strict regulations or requirements for mental health evaluations of employees, but we are taking a conservative approach in this area.

As you know, private sector nuclear power plants and other nuclear facilities fall under the purview of the Nuclear Regulatory Commission (NRC). Therefore, we have not addressed the private sector operations. We are aware that NRC has recently adopted a set of medical/physical standards for nuclear reactor operators that was developed by the American National Standards Institute. Generally, these standards follow an approach to employee mental health similar to that outlined above for ERDA employees.

It is hoped that the information provided is helpful, and we will be happy to help in any other way we can. We will keep you posted on any development of proposed rules and regulations in this area.

Sincerely,

SIGNED BY
M. B. BILES

Martin B. Biles, Director
Division of Safety, Standards,
and Compliance

bcc: AMF (w/orig mail control)
OCR (2) (w/cy of mail E control)
DA
EAA
AES
~~OCC~~

OCR #03247617 [illegible]

United States Senate
WASHINGTON, D.C. 20510

March 23, 1976

Dr. Robert C. Seamans, Jr.
Administrator
Energy Research & Development Administration
20 Massachusetts Avenue
Washington, D.C. 20545

Dear Dr. Seamans:

Within applicable rules and regulations, I would appreciate receiving a copy of your proposed rules and regulations concerning the possible necessity for mental health evaluations of employees working in nuclear power plants or other similar facilities.

Aloha,

Daniel Inouye

DANIEL K. INOUYE
United States Senator

DKI:jmpl

Forelaws on Board

F.O.B. CLEARING HOUSE
SENATOR BUILDING • PORTLAND, OREGON 97204
(503) 228-6403

April 26, 1976

*THE FOUR LAWS OF ECOLOGY

1. Everything is connected to everything else.
2. Everything must go somewhere.
3. Nature knows best.
4. There is no such thing as a free lunch.

*Reprinted by permission from THE CLOSING CIRCLE by Barry Commoner, a Borzoi Book, published by Alfred A. Knopf, Inc.

U.S. Energy Reasearch and
Development Administration
Washington, D.C. 20545

NLK did not get this letter
Yes, Transferred to NRC 4/9

To all concerned:

On March 21, 1976 we sent the enclosed letter and questionaire to hopefully be responded to. We still have not recieved any acknowledgement of our letter or any response. We would hope that if there has been some mix up in mailing that by once more sending our original letter this may allow for an eventual answer. We cannot stress enough that we feel very much dependent upon ERDA for supplying access to the kinds of factual information necessary for the decision making we are asked to make.

Respectfully submitted
Yours in the earth,

Lloyd K. Marbet

Lloyd K. Marbet
Forelaus On Board

c Senator Mark Hatfield
Senator Bob Packwood
Natural Recourses Defense Council
Oregon State Department of Energy
Oregonians for Nuclear Safeguards

Barr to Marbet
5/3/76
Barr to Marbet
5/5/76 w/additional
info

Request completed 5-3-76
Filed in Central Files - MHS-20-3

Barr
4741

Forelaws On Board

F.O.B. CLEARING HOUSE
SENATOR BUILDING • PORTLAND, OREGON 97204
(503) 220-6403

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March 21, 1976

U.S. Energy Research and
Development Administration
Washington, D.C. 20545

To the appropriate Departments:

Presently in Oregon we are being asked to make various decisions concerning the construction and operation of Nuclear Power Plants. To make an adequate decision the people need as factual information as possible. The following are various questions which we feel need to be answered adequately before any decision can be made. We do not feel that there is anyone more capable of supplying these answers than the agency responsible. We would most humbly ask for whatever help available.

Respectfully Submitted,
Yours in the earth,

Lloyd K. Marbet

Lloyd K. Marbet
Forelaws On Board

cc. Senator Mark Hatfield
Senator Bob Packwood
Natural Resourses Defense Council
Oregom State Department of Energy

[illegible] Board

F.O.B. CLEARING HOUSE
SENATOR BUILDING • PORTLAND, OREGON 97204
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page 2 QUESTIONS

1. For the next three parts of this question please use a unit of common measurement.

   In the United States:

   a. How much military waste is there and in what form? (liquid/solid) Please seperate between low level and high level.

   b. How much civilian waste is there and in what form? (low level/ high level)

   c. How much civilian waste is there expected to be generated by the year 2000?

   d. Has any commercial waste been reprocessed? If so, how much and what is its present form?

2. a. Please list all isotopes that are recycled presently for industrial and medical purposes and show what each is used for.

   b. Please show what % of commercial waste is/presently being used for these purposes and what might be projected for their use by the year 2000. (by volumn)

   c. Please show what % of these uses are for all wastes presently in existence.

3. a. Please list the amount of curies per year epostulated to be released from a 1000 megawatt coal plant and a 1000 megawatt nuclear plant under normal conditions. Please list the kinds of isotopes involved and their half-lives.

   b. Please describe what sourses and kinds of coal involve high radioactive releases versus kinds and sourses of coal that involve low radioactive releases.

   c. Please describe in what form radioactivity would be spread from a coal fired plant. (gases/particulate matter)

4. Please provide sourses of all information involved.

MAY 3 1976

Mr. Lloyd K. Marbet
Forelaws On Board
F.O.B. Clearing House
Senator Building
Portland, Oregon 97204

Dear Mr. Marbet:

The enclosed information is provided in response to questions transmitted by your letter of March 21, 1976. I trust that you will find the information useful in your effort to acquire facts relevant to decisions concerning the construction and operation of nuclear power plants in Oregon.

LETTER NOT
IN FILE
MWB
3/17/78.

Sincerely,

Nathaniel F. Barr
Assistant Director for
Special Programs
Division of Biomedical and
Environmental Research

Enclosure:
Answers to Questions

MC #4741

[illegible] ?

ANSWERS TO QUESTIONS

1a. How much military waste is there and in what form?

High level waste: About 75 million gallons, 37 million as liquid and sludge and 38 million as solids (converted).

Other than high level: About 4.3 million cu. ft. of solid waste, which includes about 12 million cu. ft. of TRU contaminated solids stored in retrievable form.

1b. How much commercial waste is there and in what form?

High level waste: About 500,000 gallons of neutralized liquid waste.

Other than high level; About 13,000,000 cu. ft. of solid waste.

1c. How much civilian waste is expected to be generated by 2000?

Through the year 2000, between 300,000 to 500,000 cu. ft. of solidified high level waste and about 7,000,000 cu. ft. of other radioactive waste (hulls and transuranium-contaminated radioactive waste) will have been accumulated and delivered to a Federal waste repository. It is estimated by that date, also, about 130,000,000 cu. ft. of low level solid waste will be buried at licensed commercial sites.

1d. Has any commercial waste been processed? If so, how much and what is its present form?

No commercial high level waste has been solidified nor is any being generated now. About 500,000 gallons of liquid high level waste was generated in the late 1960's and is now in storage at the Nuclear Fuel Services' licensed facility at West Valley, New York.

2a. Please list all isotopes that are recycled presently for industrial and medical purposes and show what each is used for.

ERDA does not keep specific records on licenses for isotopes used in the U.S. These data are kept by the Nuclear Regulatory Commission (NRC) and by the licensing authorities in states having agreements with NRC.

However, Attachment 1 sets forth the situation on radioisotopes used for industrial and medical purposes. As you can see very few of these isotopes are recycled. This reference will give you a good idea how the isotopes are made and how they are used.

In addition, the Joint Committee on Atomic Energy Report entitled, "Authorizing Appropriations for the Energy Research and Development Administration for Fiscal Year 1976 and for the Transitional Quarter Ending September 30, 1976," Report No. 94-104, dated May 6, 1975, page 33, discusses medical applications. One program, the Artificial Heart Program, utilizes plutonium-238 to drive a Stirling engine and the JCAE states, "In view of the accomplishments achieved to date with the ERDA artificial heart program, it appears that this particular program merits continuation if this country is to pursue the development of such a device." Should such a program be implemented for the general public, a large quantity of plutonium-238 would be required.

The JCAE also stated that: "In 1974 these were over 4,600,000 in vivo nuclear medicine studies performed within the U.S."

2b. Please show what % of commercial waste is presently being used for these purposes and what might be projected for their use by the year 2000 (by volume).

Today none of the commercial waste is being used for these purposes (no commercial fuel reprocessing plants are operating) and only a very small fraction of the ERDA high level (<0.1%) is being used.

In projecting to the year 2000 your attention is directed to Attachment 2, a paper entitled, "The Beneficial Utilization of Nuclear Waste Products" by G. P. Dix, dated 3/25/75. This paper projects widespread use of strontium-90, cesium-137, krypton-85, plutonium-238, curium-244, and promethium-147 by the year 2000. ERDA demonstration programs implementing the use of Sr-90, Cs-137, Kr-185, and Pu-238 are already underway. It appears that the platinum family metals (palladium, rhodium, and ruthenium) will also be used to assuage the balance of payments and provide an alternate supply of these strategic metals.

While it is difficult to define the precise % of the above isotopes in use by the year 2000, it is expected that markets for all of these isotopes and other high level waste by-products will exist. The degree of usage of each isotope will depend upon the success of ERDA's demonstration programs in the late 1970's and early 1980's. Commercial fuel reprocessors have indicated that they would be willing to separate by-product isotopes if a market exists. Should the above isotopes be fully utilized they would represent upwards of 60% of the thermal energy in all commercial high level wastes and an appreciable amount of the long term alpha and gamma emitting wastes.

2c. Please show what % of these uses are for all wastes presently in existence.

The current existing high level wastes are being stored principally at the Idaho National Engineering Laboratory, the Savannah River Plant (no isotope separation) and at Richland, Washington.

Of these wastes some krypton isotopes are being shipped to Oak Ridge for enrichment and sales to industrial and medical people. Also some of this krypton, enriched in the krypton-85 isotope, is being used for krypton light tests in coal mines and for runway lights. All of the krypton derived from the Idaho facility is being used either by industry or ERDA.

Strontium-90 and cesium-137 are being separated from the high level wastes at Richland. Some of this strontium is already in use for radiosiotope thermoelectric power production (e.g., to power Lake Clark Pass, Alaska FAA beam) and studies are being conducted now by ERDA to examine the use of strontium waste capsules (1 KW(t) each) in conjunction with a Stirling engine to power automated radar units as a replacement to the DEWLINE in order to save fuel and logistics costs.

Cesium-137 is presently under test at Albuquerque in a joint ERDA/EPA program to eliminate pathogens in sewage sludge by a thermoradiation process using the synergism of heat and radiation. This could have a major impact on cleaning up our environment since conventional processes used in sewage sludge treatment neither eliminate pathogens nor cleanse the environment. The sewage can be converted into an agricultural nutrient and save energy and natural resources.

If the strontium and cesium projects described above continue to be successful and the government continues to demonstrate in its pilot plants that the isotopes can be utilized with little or no risk, it is conceivable that all the Richland strontium and cesium could be utilized.

3a. Please list the amount of curies per year postulated to be released from a 1000 megawatt coal plant and a 1000 megawatt nuclear plant under normal conditions. Please list the kinds of isotopes involved and their half-lives.

Some of the radioisotopes discharged by operating reactors and their characteristics are listed in the table included as Attachment 3. This table is copied from ERDA's publication "Nuclear Power and the Environment."

The radioactivity emitted by fossil fueled stations is comprised of members of the naturally occurring radioactive series of uranium and thorium.

The amount of radioactivity released by fossil and nuclear stations is variable. It depends on reactor type, control systems, and type of fuel being burned.

A complete discussion of releases and control systems for light water appears in WASH-1258 (July 1973) which is the final environmental statement concerning a proposed regulation for light water reactors. The Nuclear Regulatory Commission issues regular reports on actual emissions of radioactivity from licensed power reactors.

A discussion of the nature and amounts of radioactivity emitted during combustion of fossil fuels is provided in an article by Eisenbud and Petrow (Science, April 17, 1964, page 288).

3b. Please describe what sources and kinds of coal involve high radioactive releases versus kinds and sources of coal that involve low radioactive releases.

Coal being burned today contains approximately 1-10 ppm of uranium with varying concentrations of daughter radioactivity present. Generally the amount of natural radioactivity present in coal increases as the heat quality of the coal decreases. Some lignites in the mid-West contain very much larger concentrations of natural radioactivity. (U.S. Geological Survey Bulletin #1055, Washington, D. C. 1959.)

3c. Please describe in what form radioactivity would be spread from a coal fired plant.

Radioactivity from a fossil fuel plant is dispersed as gaseous radon, and uranium and thorium daughters attached to and embedded in ash particles of various sizes.

4. Please provide sources of all information involved.

The reply for question 1 is based on ERDA staff estimates. Sources for other information are included in the replies.

Education for Environmental Protection · Post Office Box 203 · Summit New Jersey 07901

August 18, 1976

RECEIVED
1976 SEP 2 PM 4:51
DIVISION OF NUCLEAR FUEL CYCLE AND PRODUCTION

Hon. Clifford P. Case
Senate Office Building
Washington, D.C. 20510

Dear Senator Case:

KEEP members have voted to support legislation which would ban the construction of new nuclear plants for three years, until it can be shown that there is a fail-safe method of containing Plutonium and disposing of radioactive wastes. If after that time, no such method has been found, we believe the nation should reassess its energy program.

Specifically, we believe it is not too soon for different "scenarios" to be drawn up which envision alternative options the country can take in relatively short time:

1. If migration of radionuclides from inert substances into living organic substances is shown to occur at a faster rate than previously estimated, and a projection of its effect on the biosystem indicates rapid deterioration of health for animals and humans; bER

2. If terrorist activity in other parts of the world becomes uncontrollable save through the most extreme means, increasing several fold the danger of extortion or theft of plutonium; DSS

3. A major accident involving a nuclear plant occurs — either as a result of defective equipment, operation or human fallibility or instability, releasing unsupportable quantities of toxic radioactivity into the atmosphere; NRC

so that economic dislocation is minimized, steady supplies of substitute energy can be delivered, should it be deemed advisable to shut down all or a large number of nuclear generating stations.

We are aware that the Federal Preparedness Agency has drafted a disaster plan to cope with the casualties, property damage and loss of civil control that would result from a serious nuclear accident or attack on a nuclear plant. However, in addition to such preparedness, we believe it would be wise to design alternative energy supply delivery systems which would appear to be necessary to lessen the damaging effect; to provide a fall-back for regions affected and assuring greater latitude to executive governments in charge to continue to function without nuclear power generation.

Sincerely,
Claire Schiff
Claire Schiff,
President

DEC 6 1976

Miss Pamela Nations [illegible]
2227 N. Bonita
Shawnee, Oklahoma 74801

Dear Miss Nations:

I am sorry that we were not able to respond to your request for information by your November 22 deadline. In part this was because the request was so broad that we were at a loss as to how to respond. I hope that you are aware of the vast amount of literature relevant to impacts of nuclear power plants on the environment and that you have taken advantage of your own library resources to get at this. We have on hand only limited materials to send out.

There is more and more information all the time which suggests that the most serious aspects of nuclear power plant impacts may be quite unrelated to the fact that uranium is used to produce the heat which generates the power. That is to say, most of the problems we are aware of, and temperature is no longer one of them, exist regardless of whether the heat comes from uranium, coal, oil or any other source. Some of the reasons behind this are explored in the enclosed booklet from ERDA which I hope will be of some help to you.

Sincerely yours,

D. Heyward Hamilton
Aquatic Ecologist
Environmental Programs
Division of Biomedical and
Environmental Research

Enclosure:
As stated

bcc: EP Reading File

No. [illegible]

Oklahoma
Baptist
University

SHAWNEE, OKLAHOMA 74801

November 8, 1976

ERDA Headquarters
Division of Biomedical & Environmental Research
20 Massachusetts Avenue NW
Washington DC 20545

Dear Sirs,

I am a student attending Oklahoma Baptist University, and in my Biology class, I have been assigned an Ecology paper. I have chosen to write on the dangers of nuclear power plants to the environment and I would greatly appreciate any information which you could send me on the subject. I need this information to be rushed please. I really need it by Nov, 22. Thank you very much.

Pamela Nations
2227 N. Bonita
Shawnee, Okla. 74801

Mr. Dale A. Clinbeard
The Autonomist Society
P. O. Box 1457
Grand Forks, North Dakota 58201

Dear Mr. Clinbeard:

Thank you for your letter of December 22, 1976. We appreciate the opportunity to assist you in your efforts to inform the public with respect to information concerning nuclear power plants and the environment.

There is, as I am sure you are aware, a tremendous amount of literature available on this general subject. *Nuclear Science Abstracts* alone contains tens of thousands of references. Perhaps more relevant to your particular request is the fact that an Environmental Impact Statement must be prepared for each new reactor as a part of the licensing procedure of the Nuclear Regulatory Commission (NRC). Included in such Statements are discussions of the anticipated impact of the facility upon the environment and the public. These Statements may be obtained from the NRC. A few brochures of a general nature on the subject matter are enclosed.

Of particular interest might be an Atomic Energy Commission publication, "The Safety of Nuclear Power Reactors (Light Water-Cooled) and Related Facilities," (WASH-1250), July 1973. If you wish a copy of this document, please write to USERDA-Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

In addition you requested information related to the toxicity of plutonium and transportation of plutonium and enriched uranium. Several documents addressing the transportation of radioactive materials to and from nuclear facilities are enclosed.

A list of recent references discussing the toxicity of plutonium also is enclosed. While some of this reference material is provided to you, we regret that we cannot provide copies of each of the references; the length of many of the articles and books precludes us from doing so. In some cases, however, tables of contents are provided so that you may judge the appropriateness of the reference for your purposes. We would suggest that these references might be available from a large city library, a university library, or the publisher.

We trust that this information will be of assistance to you.

Sincerely,

Original signed by
W. W. Burr, Jr., M.D.

James L. Liverman, Director
Division of Biomedical and
Environmental Research

Enclosures:
See separate list

LIST OF ENCLOSURES

1. "Atoms on the Move - Transporting Nuclear Material," Joseph M. Dukert, ERDA, Office of Public Affairs, Washington, D.C. 20545.
2. "Nuclear Power and the Environment," U. S. Atomic Energy Commission, Division of Technical Information, 1969.
3. "Nuclear Power and the Environment," Joseph M. Dukert, ERDA, Office of Public Affairs, Washington, D.C. 20545.
4. "IAEA - Nuclear Energy and the Environment, Addendum to the Agency's Report to the Economic and Social Council of the United Nations for 1969-70." INFCIRC/139/Add.1.
5. "Shipments of Nuclear Fuel and Waste...Are They Really Safe?", WASH-1339, Transportation Branch, Division of Waste Management and Transportation, U.S. Atomic Energy Commission, Washington, D.C. 20545, August 1974.
6. "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," WASH-1238, Directorate of Regulatory Standards, U.S. Atomic Energy Commission. December 1972.
7. "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, Supplement 1," WASH-1238, Office of Standards Development, U.S. Nuclear Regulatory Commission, NUREG-75/038.
8. List of Plutonium References with enclosures as noted.

Plutonium References

1. Hodge, H. C., Stannard, J. N., and Hursh, J. B., "Uranium, Plutonium, Transplutonic Elements," Springer-Verlag, New York, 1973 (Copy of Table of Contents enclosed).

2. Stover, B. J. and Jee, W. S. S., "Radiobiology of Plutonium," J. W. Press, Department of Anatomy, University of Utah, Salt Lake City, Utah, 1972 (Copy of Table of Contents enclosed).

3. Bair, W. J., "Toxicology of Plutonium," In: Advances in Radiation Biology, Vol. 4, Academic Press, 1974. (Enclosed).

4. Public Hearing Record, May 27-28, 1975, on the Proposed Final Environmental Statement WASH-1535 (December 1974) for the Liquid Metal Fast Breeder Reactor Program, Vol. III, June 1975, USERDA (Section on Comments on Hearing Transcript enclosed).

5. Jee, W. S. S., "The Health Effects of Plutonium and Radium," J. W. Press, University of Utah, Salt Lake City, Utah, 1976 (Copy of Table of Contents enclosed).

6. "Proposed Final Environmental Statement, Liquid Metal Fast Breeder Reactor Program," WASH-1535, Vol. 2 of 7, USAEC, December 1974. (Section 4.7 and Appendix II.G enclosed).

7. "The Toxicity of Plutonium," Medical Research Council, Her Majesty's Stationery Office, London, 1975. (Enclosed).

8. Bair, W. J. and Thompson, R. C., "Plutonium: Biomedical Research." (Enclosed).

9. "Plutonium Information Meeting for an Ad Hoc Subcommittee of the Advisory Committee on Reactor Safeguards," CONF-740115, USAEC, December 1974. (Copy of Table of Contents enclosed).

10. "Review of National Breeder Reactor Program, Report by the Ad Hoc Subcommittee to Review the Liquid Metal Fast Breeder Reactor Program of the Joint Committee on Atomic Energy, Congress of the United States," U. S. Government Printing Office, Washington, D. C., January 1976. (Enclosed).

22 December 1976
P O Box 1457
Grand Forks, ND 58201

Atomic Energy Commission
Division of Biomedical &
Environmental Research
Washington, D. C. 20545

Gentlemen,

The Autonomist Society, a non-profit organization dedicated to promoting the will of the informed public, is currently engaged in determining the impact of nuclear power plants on the public and the environment. If you have any information available which is pertinent to our endeavor, please send to:

Reactor Repercussions
The Autonomist Society
P O Box 1457
Grand Forks, ND 58201

We are especially interested in obtaining any information you may have regarding the toxicity of Plutonium and safeguard requirements associated with transporting Plutonium and enriched Uranium. Your cooperation will be greatly appreciated.

Sincerely,

Dale A. Clinbeard
Founder

JUN 1 1977

Mr. Paul Holowka
R - 4
York, Pennsylvania 17404

Dear Mr. Holowka:

I have received your letter of May 18, 1977. I am sorry that the facts outlined in my letter of May 16, did not alleviate your concern that the nuclear power plant at Peach Bottom is responsible for your problems with your crops and animals.

I can only reiterate that emissions from all nuclear power plants are closely monitored to make sure that the health and safety standards are not exceeded, and that these standards are set sufficiently low so that the types of problems which you have described can in no way occur as the result of nuclear power plant emissions.

If your concern continues, may I suggest that you contact your county agricultural extension agent so that he may see first-hand the problems which you have described in your letter. He may be able to suggest the reasons for your problems and offer appropriate suggestions.

Sincerely,

Original signed by
W. W. Burr, Jr., M.D.

James L. Liverman, Director
Division of Biomedical and
Environmental Research

NOTE:
Referred letter
and reply not
in file. MB
3/17/78.
659A

MHS-20-3

R-4
York Pa 17404
May 18, 1977

ivision of Biomedical &
nvironmental Research

Dear Mr. Liverman;

I received your letter of May 16 denying the
uths, facts and findings that I observed and found
out the nuclear plants in our Susquehanna Valley.
The barley, balbo rye and my wheat have been
our possession for years and have not been
rifed like you said it was for development and
which like you said it was. The truth is that
nuclear plants dwarfed it.

The last week of March the 3 mile Island plants
ere shut down till May 16. The atmosphere around
e was crystal clear even on rainy days except
the Peach bottom area. Now the plants have
umed operation and the thick blue haze is back
ain. This blue haze is due to the air being
arged by the effects of the atomic reactors just
the north pole magnetic power affects the
npass needle. The clover and vegetation has
tten blistered. That blue haze has shut out the
n so that you can look at the sun at 6:00 P.M.
el dark and it gets darker quicker, too. It
fected the sunshine so that it is brown
r bronze sunshine. Do you mean to tell me
nd others that this is healthy? And do you mean
i deny this even though you are paid out of
us tax dollars to serve us faithfully and tru
[illegible] aaina to give us the hocus pocus
[illegible] The hair sprays

mbs the ladie use. On the ho. is [illegible]
d story that the Chinese bomb did that.
The truth is that the three mile island
nuclear plants did this and that the blue
haze is due to nuclear plants in the country,
nd that unusual weather is due to the nuclear
lants.
Radiologists have seen me and none of them
knew what barley, wheat, rye and orchard
rass was and could not tell the difference,
nd they were telling me just like you are, how
od nuclear energy was and some were grow
n their thirties, I'm older than Dr ~~that~~ Schlen-
ger and have been farming no doubt longer
an you are old. You have no right to
to tell me that I don't know what I'm
lking about. What's more you or the government
o not have the right to impose a deathful
ing like those nuclear plants on anybody or
hinder anybody from making a livelihood,
ith the affects of nuclear energy. You don't
ed electricity that bad nor does anybody else.
why don't you come out into the country
d see the short barley, wheat rye, hay, pastures
d the blue haze yourself instead of just sitting
here in the office? If anything your letter
id it reinforced the bad opinions people have
f bureaucrats and politicians. Your letter is
very interesting letter indeed. It raises a lot
f doubt concerning credibility.

Yours Truly,

DEC 19 1977

Mr. George L. Hagen, President
Bucks County Land Use Task Force
Routes 202 & 413, P. O. Box 144
Buckingham, PA 18912

Dear Mr. Hagen:

Thank you for your letter (undated) to Secretary Schlesinger of the Department of Energy (DOE) transmitting a copy of a September 16, 1977, petition from the Bucks County Board of Supervisors to President Carter which requested that the proposed Point Pleasant Diversion Plan not be carried forward at this time and that the Council on Environmental Quality (CEQ) or some appropriate agency conduct additional analysis of the proposed Plan. Secretary Schlesinger has referred your letter to this office for reply.

Your letter to Secretary Schlesinger also urges DOE to consider environmental effects of the Point Pleasant project and to provide assistance to ensure preparation of an Environmental Impact Statement (EIS) that appropriately considers alternatives, all side effects, and long-term impacts, etc. Although DOE has direct interests in the proper use of national and regional resources (including water) and in the proper protection of the environment during such use, it does not appear to us that our agency is the proper one for primary responsibility in reviewing the questions you have outlined concerning the Point Pleasant project. For example, the questions about:

a) the use of Point Pleasant water for cooling the Limerick nuclear power plant,

b) the impacts of the Point Pleasant project in the context of the total regional water system, including potential effects on increased development in Bucks County,

c) the uncertain status of the proposed Tocks Island reservoir, and

d) the potential for carcinogens in the Delaware River and compliance with requirements of the Safe Drinking Water Act and Water Pollution Control Act

MHS-20-3

would appear to be the primary concerns of the Nuclear Regulatory Commission (NRC), the Delaware River Basin Commission (DRBC), and the Environmental Protection Agency (EPA).

We have discussed the petition and related correspondence with the staffs of NRC and DRBC. Based on these discussions, it does not appear that there is any immediately obvious area of major concern in areas that might fall within the responsibility of this agency. For example, we have been advised that, although it is true that individual water system components are most often examined on a case-by-case basis, the overall regional water system including Point Pleasant has been discussed in the Soil Conservation Service EIS on the Neshaminy Creek development, in the forthcoming environmental report by the Neshaminy Water Resources Authority, and in the Comprehensive Plan of the DRBC. With respect to potential impacts, we understand that DRBC will also be updating the Point Pleasant EIS when additional engineering details are available. We also understand that, prior to issuance of any operating license for the Limerick plant, NRC will be updating its reviews of the Limerick plant to account for latest projections of regional conditions; in addition, the earlier NRC analyses conducted prior to issuing the construction permit for Limerick used conservative population assumptions that are thought to cover additional regional development (if any) that might occur because of Point Pleasant.

With respect to possible relationships between Point Pleasant and the cooling requirements of Limerick and potential need for additional reservoirs (such as Tocks Island) to ensure adequate long-term supply, NRC advises us that the existing licenses were issued on the condition that utilities either must supply their own low-flow augmentation facilities or must agree to operate on a reduced generation, "river-follower" basis when flows are low. Consequently, although Point Pleasant is apparently intended to supply either domestic water to the Neshaminy Creek or industrial cooling water to the Perkiomen Creek, it does not appear that any new concerns have arisen related to cooling water for Limerick that would be likely to influence additional reviews of Point Pleasant.

With respect to the influence of Tocks Island uncertainties on Point Pleasant evaluations, we understand that Tocks Island remains a part of the DRBC Comprehensive Plan (although dormant). It appears that no specific DRBC recommendation has yet been made to deauthorize Tocks Island; although the DRBC has recently rejected a recommendation that Congress appropriate funds for construction, we understand that the DRBC has also recently approved a recommendation that Congress appropriate funds to complete land acquisition in the project area.

From the above, it does not appear appropriate that the Department of Energy take any specific action, at present, to initiate further reviews of the concerns you have outlined. However, staff members of this office serve as Washington liaison representatives of the DRBC Federal Commissioner, and we will be glad to offer any assistance we can in any future reviews undertaken by DRBC or by NRC.

Thank you again for the opportunity to comment on the petition to President Carter.

Sincerely,
Original signed by
James L. Liverman

James L. Liverman
Acting Assistant Secretary
for Environment

cc: Sherman W. Tribbitt, U.S.
Commissioner, DRBC

bcc: Voss Moore, NRC
P. Cota, NRC
P. Flynn, FERC
P. House, OASEV
XS(3)
R. Barber, NSC

Record Note:

Contents and tone of this response were discussed with NRC staff (Phil Cota) and DRBC staff (Barbara Shipler). They have no objection. DRBC is preparing a separate letter to Hagen for Secretary Andrus of DOI in reply to a similar request for assistance by Bucks County.

MC#17154 (XS#0053)

BUCKS COUNTY LAND USE TASK FORCE
ROUTES 202 & 413, P. O. BOX 144 • BUCKINGHAM, PENNSYLVANIA 18912

1977 NOV 16 PM 3 37

Secretary Schlesinger
Department of the Environment
Washington D. C.

Dear Secretary Schlesinger:

Enclosed pleas find a petition of the Board of Supervisors of Buckingham Township, Bucks County, Pennsylvania--and an endorsement of that position by the Bucks County Land Use Task Force - both of which have been sent to the President.

We urge you to consider the potential longterm effects, environmental and otherwise of this proposed project. Our understanding of (1) new lower population projections for the area, (2) the lack of a study of local ground water supply, and (3) the lack of study of potential carcinogens in Delaware River water make the already completed EIS's out of date.

Your assistance to assure an overall IES, including alternatives, accountability and complete recognition of all side effects is essential for sound environmental planning.

Your attention and assistance in this matter will be appreciated.

Sincerely,

George L. Hagen, President

cc: Department of Environment
Harrisburg, Penna

P. O. Box 413
Buckingham, Pa. 18912

oard of Supervisors
ames Gemmell, 3rd, Chairman
dward L. Heim, Vice-Chairman
aul Silver

Township Manager
Leonard H. Point
Ph. (215) 794-8834

September 16, 1977

The President,
White House,
Washington, D.C. 20500

Sir:

It is the position of this Board, the Board of Supervisors of Buckingham Township, Bucks County, Pennsylvania, that the proposed Point Pleasant Diversion Plan should not be carried forward at this time because, in general, its Economic and Environmental Impacts have been insufficiently studied. The Regional Water System, of which a Point Pleasant Diversion facility would be the key element, has been studied component by component, not in its totality, and all these studies were conductdd when conditions, policies and regulations were radically different from what they are today, and are therefore obsolete.

For these reasons, and those considerations set forth below, among others, the Board of Supervisors of Buckingham Township petitions the President of the United States, and through him the Council on Environmental Quality, to conduct, or direct the appropriate agency to conduct, a Total Systems Analysis of the Regional Water System to determine:

1- 1) The Purposes and Goals of the Water System and the likelihood of achieving them.

2- 2) The immediate and the unavoidable secondary Costs of the System.

3- 3) The Economic Benefit/Cost ratio of the System, short-term and long-term, including therein such "secondary Costs" as the increasing demand for energy (in all forms) associated with the development that might be promoted by the Water System, the need for supplementary water-impoundment facilities, and the foreseeable need to upgrade the water-purification facility.

4- 4) The Environmental Benefit/Cost ratio, short-term and long-term.

5- 5) The Benefit/Risk ratio associated with the use of Delaware River water as drinking water.

6- 6) The Compliance of the proposed System, substantively and procedurally, with Federal regulations, including but not limited to the Safe Drinking Water Act and Water Pollution Control Act.

7- 7) The Consistency of the proposed Water System with recently enunciated Administration policies, for example, the conservation of energy, the conservation of water by economically sound and environmentally sensitive means and, in general, the conservation and preservation of all our natural resources, including prime agricultural lands.

8- 8) The feasibility of Alternative sources of water supply consistent with good natural-resource management and the goals established in the comprehensive plan of the county most directly involved, Bucks County.

Mr. President, we petition your intercession in light of the following considerations:

9- . The Delaware River Basin Commission will not re-review the environmental impact of the Diversion Plan, originally assessed in 1970 and 1971 on the basis of 1968 and 1969 data, unless there are "major changes" in the Plan. This despite the subsequent enactment of the aforementioned Safe Drinking Water Act and Water Pollution Control Act, changes in population projections for the areas to be served with drinking water, a change in the status of the Tocks Island Dam, and no knowledge of the current quality status of Delaware River water in the region of concern.

10- . Given the new Federal drinking water standards, and those yet to be promulgated, there is reason to think the economic analysis of the original Impact Statement cannot reflect the present costs. Given the lack of information on the quality of Delaware River water, we do not know whether present or foreseeable standards can be met. Relatedly, there is the question of why the residents of the area concerned should turn from groundwater to water that is a vehicle for industrial effluents.

11- . There is reason to think that the anticipated withdrawals from the Delaware will adversely effect downstream communities (including Philadelphia and Trenton, New Jersey); and that the plans for "interim flow augmentation" are ill-conceived and insufficiently studied to demonstrate their validity.

12- We are aware, Mr. President, of the difficulties you have faced in halting water projects most notable for their diseconomies. We believe that the comprehensive analysis called for here might help to establish a model for the evaluation of water programs. Existing water facilities, built in part with Federal funds, can stand as a functional unit without the addition of the Point Pleasant Diversion facility (Pumping Station). Nothing is lost if the program stops at this point.

It will be said by some that no further Federal expenditures are contemplated, and therefore there is no basis for requiring an additional impact statement. On the contrary, the original impact statement, and present DRBC plans, anticipate additional facilities constructed with Federal monies. In addition, the draft contract between Bucks and Montgomery counties for the sale of water — the signing of which will precipitate implementation of the Diversion scheme — specifically suggests that the parties seek Federal monies and subsidies for the construction of facilities.

Over a period of years, Mr. President, inquiries into the evolution of the Water System plan have returned little information of substance. Most important, perhaps, is the fact that no one -- person or agency -- is accountable for the System as it inches its way toward a new order of magnitude...one that carries the seeds for ever-increasing growth. Given this set of facts, we appeal to you -- as the only person in a position to provide the appropriate oversight for this entire System -- to establish a mechanism that will provide the answers that so many of us are seeking. Perhaps it is the memory of one of your predecessors that has us turn in your direction. He, Mr. Truman, was known to comment that "The buck stops here." It certainly has not stopped at any lower level of authority.

Sincerely,

BUCKINGHAM TOWNSHIP BOARD OF SUPERVISORS.

James Gemmell, III, Chairman

Edward L. Reim

Edward L. Reim

Paul Silver

P.S. Additional subscribers to this Petition will forward their versions in a short while.

PS:g

BUCKS COUNTY LAND USE TASK FORCE
ROUTES 202 & 413, P. O. BOX 144 • BUCKINGHAM, PENNSYLVANIA 18912

September 29, 1977

Office of the President
The White House
Washington, D.C.

RE: Support of the Buckingham Township Presidential Petition on the subject of the Point Pleasant (Penna.) Diversion Plan and associated Water System.

Dear Mr. President:

We understand you have received a resolution/petition from the Board of Supervisors of Buckingham Township, Bucks County, Pennsylvania concerning the proposed plan to divert water from the Delaware River at Point Pleasant (Bucks County) to supply coolant to the Limerick Nuclear Power Plant, which is on the Schuylkill River in Montgomery County. This plan will also "provide water to the rapidly urbanizing sections of both Bucks and Montgomery Counties," according to the Environmental Impact Statement prepared in 1971 by the Delaware River Basin Commission.

Mr. President, we fully endorse the positions taken in the resolution. We would also like to make the following points.

Four years of research suggest to us that the primary purpose of this water project, in its present form, is to promote growth in the farmland along the Philadelphia urban fringe. Population projections for these regions have fallen since 1971, according to the Delaware Valley Regional Planning Commission, and at no time did they justify such expenditures.

All communities (excepting cities) should strive to maintain self-sufficiency with respect to water resources, as advocated in the Water Pollution Control Act. Intervention of the proposed type destroys groundwater resources and burdens local communities (and the governmental agencies providing subsidies) with expensive systems that supply water of a quality that is increasingly suspect. It also triggers a need for economically and environmentally unsound waste-water systems, systems that further diminish the quantity and quality of our water resources.

The Impact Statement prepared for the Limerick nuclear plant by the A.E.C. may be flawed and negated if the population in the vicinity of, and down-wind of, the power station is to become "urban."

Our understanding of the Point Pleasant E.I.S. indicates that a major change has occurred in the Diversion Plan since it was approved in 1971. The Delaware River Basin Commission, a four-state "compact," has rejected the Tocks Island Dam project; it, or its equivalent, was considered essential to the water program. (Our

Congressman, Peter Kostmayer -- Dem., Pa. 8th C.D. -- has, in fact, introduced legislation to deauthorize the Tocks Island Dam.) It could be inferred that the staff of the DRBC, in refusing to re-review the '71 approval, is determined to force the construction of Tocks Island on a step-by-step basis, using "interim" water impoundments designed for other uses...and therefore not permanently available to the System.

We would also emphasize, Mr. President, that the policies of your Administration are not those of 1971; urban sprawl and its diseconomies are to be discouraged, while the conservation of energy and water are to be encouraged. It was in the hope of seeing such policies -- including your recently proposed Urban Development Fund program -- forcefully implemented that the Land Use Task Force ardently supported your candidacy. We believe these are survival issues. Knowing that you are concerned about uneconomic water projects, we hope you will establish the means to answer the questions raised by the enlightened resolution of the Buckingham supervisors. We, too, would like to know the economic and natural-resource costs of continuing the referenced regional water scheme. We, too, are concerned that, in such a significant area, accountability and responsiveness are not yet found.

Sincerely,

George L. Hagen, Ph.D.
President

GLH:ps

cc:
Buckingham Township
Board of Supervisors
Rep. Peter Kostmayer

DEC 20 1977

Ms. Zelda Braudy
1204 N. 28th Street
Philadelphia, Pennsylvania 19121

Dear Ms. Braudy:

Your letter of November 4, 1977, to President Carter has been referred to the Department of Energy. I am pleased to have the opportunity to respond to your concerns.

The newspaper article which apparently formed the basis for your concern and your opinion regarding nuclear power would indeed be alarming if it were factually correct.

Apparently some newspapers, including The Pittsburgh Press, chose not, to print the article. (Pittsburgh, 30 miles from Shippingport, is the nearest major metropolitan area.) Subsequently, The Press was criticized for its decision not to do so. The editor of The Press, Mr. John Troan, explained and defended his action in the enclosed article (enclosure 1), which may be of interest to you.

Being next door neighbors, figuratively speaking, of Shippingport, The Press for many years has been interested in and reported the circumstances at Shippingport, and, on occasion, has been vocal in its opinion. Clearly then, The Press regarded the article to which you refer as "inaccurate." We note also that other newspapers, such as The Washington Post, chose to omit all or portions of several paragraphs (e.g., the reference to birds walking backwards, gases seeping out of plants, etc.).

While it would be possible to address each of the allegations in the article point by point, we might summarize the major points as follows:

1) There are several commercial coal fired plants and a single commercial nuclear power plant in the general area. In addition, there is one Government-owned, contractor-operated nuclear power plant. It is not clear from the article what is said to be a result of which plant. For example, the cooling towers and desulfurization process are associated with the coal facilities, not the nuclear ones, despite the reference to "irradiated mist."

2) Cooling towers emit steam; there is no basis to suspect that lead, cadmium, chromium, iron or an irradiated mist are emitted from the nuclear cooling towers. One of the fossil fuel power plants approximately a mile from the nuclear plants did experience a malfunction in their flue gas desulfurization equipment. As a result, on a few occasions, calcium sulfate flakes broke away from deposits in the stack, were released from the stack, and fell to the ground near the plant. The largest of these flakes was about an inch in diameter and caused no harm. This malfunction has been corrected.

3) The accidental release of 9,000 gallons of tritium contaminated water last July was promptly reported to the Commonwealth of Pennsylvania and the Nuclear Regulatory Commission. A portion of this material entered the Ohio River. Water samples taken downstream of the drain and analyzed for tritium showed concentration 100 times lower than limiting concentrations recommended by the International Commission on Radiological Protection and by the National Council on Radiation Protection and Measurements; these water samples were taken and analyzed by several interested parties, including the Environmental Protection Agency and the Pennsylvania Department of Environmental Resources.

4) The allegations of Dr. Sternglass have received extensive attention both within and outside of the scientific community. Many knowledgeable persons and organizations have reviewed his findings and found them to be unsubstantiated by the data he presents. A partial list of those reviewing his allegations and disagreeing with his conclusions include:

   a) A special investigating committee appointed in 1974 by Governor Shapp of Pennsylvania

   b) The U. S. Public Health Service

   c) The U. S. Environmental Protection Agency

   d) The New York State Department of Health

   e) The Michigan Department of Public Health

   f) The State of Illinois

   g) All presidents of the Health Physics Society (holding office up to or at the time of the statement--1971)

h) The American Academy of Pediatrics

Many of these and other opinions are quoted and summarized in enclosure 2.

5) The General Accounting Office report to which reference is made addresses the overall national monitoring program of the U. S. Environmental Protection Agency. It does not address the specific area in question which has been monitored by numerous Federal and state agencies, as well as by other interests.

In conclusion, we feel the article to which you refer is inaccurate and irresponsible, so much so that The Pittsburgh Press labelled it "so inaccurately tied together as to be grossly misleading." We very much regret that such a source would be the only information available to you. If there is any way we can provide you with additional information, we would be pleased to comply with your request.

It is only on the basis of a factually informed citizenry that the United States can seek to explore the potential of and resolve the problems associated with all energy technologies so that we may reduce our dependency on foreign resources.

We appreciate your concern and thank you for sharing your thoughts with President Carter and with us. We hope that we have been helpful in responding to your letter.

Sincerely,

Original signed by
W. W. Burr, Jr., M.D.

James L. Liverman, Director
Division of Biomedical and
Environmental Research

Enclosures:
As stated

bcc: XS (2)
Director's Office
Dr. Wachholz
EV/MF

MC 16886 & 11-14-77-819

November 4, 1977
1204 N. 28th St.
Philadelphia
PA 19121

President Jimmy Carter
The White House
1600 Pennsylvania Ave.
Washington, D.C. 20500

My dear Mr. President:

I live hundreds of miles from Shippingport, Pa., but this article makes my hair stand on end.

When scientists first anticipated the possibilities which would accrue if and when the atom would be split, they talked of the benefits to mankind. How wrong they were. We would be far better off with wood-burning stoves and candle-light and horse-drawn carriages.

I realize there is no way back, because it would affect the economy.

Thanks for listening.

Sincerely,

Zelda Braudy

Zelda Braudy

DEC 20 1977

Mr. Walter Tomasch
Route 45
Spring Hills, Pennsylvania 16875

Dear Mr. Tomasch:

Your letter of November 3, 1977, to President Carter has been referred to the Department of Energy. I am pleased to have the opportunity to respond to your concerns.

The newspaper article which apparently formed the basis for your concern and your opinion regarding nuclear power would indeed be alarming if it were factually correct.

Apparently some newspapers, including The Pittsburgh Press, chose not to print the article. (Pittsburgh, 30 miles from Shippingport, is the nearest major metropolitan area.) Subsequently, The Press was criticized for its decision not to do so. The editor of The Press, Mr. John Troan, explained and defended his action in the enclosed article (enclosure 1), which may be of interest to you.

Being next door neighbors, figuratively speaking, of Shippingport, The Press for many years has been interested in and reported the circumstances at Shippingport, and, on occasion, has been vocal in its opinion. Clearly, then, The Press regarded the article to which you refer as "inaccurate." We note also that other newspapers, such as The Washington Post, chose to omit all or portions of several paragraphs (e.g., the reference to birds walking backwards, gases seeping out of plants, etc.).

While it would be possible to address each of the allegations in the article point by point, we might summarize the major points as follows:

1) There are several commercial coal fired plants and a single commercial nuclear power plant in the general area. In addition, there is one Government-owned, contractor-operated nuclear power plant. It is not clear from the article what is said to be a result of which plant. For example, the cooling towers and desulfurization process are associated with the coal facilities, not the nuclear ones, despite the reference to "irradiated mist."

MHS-30-3

ERDA

TOMASCH PAINT & GLASS
RT. 45, SPRING MILLS, PA. 16875
PHONE 814 - 422-8191

Opp. nuc. p. plants

3 Nov 77

President Carter
Washington D.C.

Down with more money for Atomic power plants!

After reading the horror story of the Shippingport Pa power plant in Jack Andersons colum I am more convinced then ever that Atomic power plants are a horror for us and our children. No more should be built. The present ones should be eliminated.

16887

Yours truly
Walter [illegible]

December 22, 1977

Honorable Robert J. Dole
United States Senate
4213 Dirksen Office Building
Washington, D.C. 20510
ATTN: Ray Wiseman

Dear Ms. Wiseman:

Enclosed is the information requested on radiation coming from nuclear power plants. I hope this is useful to your constituent. If we can assist you further, please call.

Sincerely,

Jan Cool
Office of the Assistant Secretary
for Environment

Enclosures

EV
JCool:dh
12/22/77

Please send material to [illegible] [illegible] safety precautions [illegible] nuclear plan

[illegible] Herman Schroeder
829 Dewey Boulevard, Manitowoc, Wisconsin 54220

1-25-78

1978 FEB -1 AM 9 00

Mr. Pagnotta

Thank you for the reply - I thought it had gone in the shredder for recycle - by the Pre-reader

Now then I did request Mr Schlesinger to call me by phone I do have very important suggestion - but as long as you are close to him - I will tell and I am sure you will show the Boss Nuclear Power Plants - which we have two in one Plant and another up the road 2 miles - a single - My good friend and boating buddie - Contract Sales officer - I queried him about the Personel - all the way up to the Crew - (3 man) to find out about the Uniforms and Wear - and capabilities of Knowledge of this Most dangerous Work changing Fuel Rods - discription [illegible] Rooms and [illegible] to get there. Only these Men know - Nobody else in all the Plants Personel - Nobody queried Nobody

3 - 3 man crews and relief - each plant - each different

With now if some body diverted the water so the pipes into the plant [illegible] [illegible] - Something has to crumble and all hell could be out of hand - I picture these men and all other personel vacating the Plant as fast as possible - I capable - who then Fixes - the State - County - local Police or the line Crew - Here's How cause ensuing - Then I asked - [illegible] tell me - Where are the Protective Suits Needed to Enter.

Harlan Schroeder
829 Dewey Boulevard, Manitowoc, Wisconsin 54220

the Plant - the relief Crews are coming - Aren You -
You want me to tell you the Suits are all way up into the
Danger Rooms - Your right they are - no Place else? No

Well now You are Mr Electric - like Mr Sound So the President
of the Company - We expect you and him to Fix - a loud mad
Me? and him Bookwork - who else - I shot back
Your Capable Men - Helpless without the Suits and Head
gear - they ran faster away than the other personell

I just want trained Personel - many miles away - every
Facet of the Plant they are capable to get to the Problem
and Fix - with suits and headgear on their Bodies
when they get to the Trouble Plant
Now Mr Schlesinger you Quite same as I - they Blow your stack
when You have these Nuclear Plant - Know-it alls - in the room

only Electric Plant men understand Electric
Me I know how to push a wall switch - ON - off. thats all
Im sure Everybody else - equally helpless

Was I wrong to question this suit Problem? dam Im 68
and thinking of the Younger - Expected Safeguard

Harlan

NOTE:
Referred letters & replies not in file.
MMB 3/17/80

JAN 26 1978

Mr. Jacob D. Dumelle, Chairman
State of Illinois
Pollution Control Board
309 West Washington Street
Suite 300
Chicago, Illinois 60606

Dear Mr. Dumelle:

Last November you corresponded with the Department of Energy regarding your concerns about present and future releases of tritium from nuclear power plants to Lake Michigan. The series of questions you posed covered a broad spectrum, ranging from regulatory operational data on Lake Michigan nuclear power plants to radiological monitoring and radiation exposure (both present and future) queries that have required considerable analysis in order to obtain some perspective on the overall subject.

The enclosed critique has been prepared from data and information provided through discussions and material obtained from scientific staff at Argonne National Laboratory, Chicago, and the Nuclear Regulatory Commission in Washington, D.C. I hope the information provides you and your staff with the analytical data and insight on the topic you have desired. If you have further specific questions, may I suggest your staff making direct contact with:

Mr. Philip F. Gustafson, Director
Division of Environmental Impact Studies
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

Your interest in this phase of our overall program is appreciated.

Sincerely,

Walter G. Belter
Assistant Director
for Technology Liaison
Division of Regional Assessments

bcc w/encl:
P. Gustafson, ANL
G. Knighton, NRC
J. Coleman/B. Wachholz, OTI
J. Maher, TO
A. Schoen, OES

STATE OF ILLINOIS
POLLUTION CONTROL BOARD
309 WEST WASHINGTON STREET SUITE 300
CHICAGO, ILLINOIS 60606
TELEPHONE
312-793-3620

JACOB D. DUMELLE, CHAIRMAN
OAK PARK, ILLINOIS
RVIN G. GOODMAN
MEDINAH, ILLINOIS
DONALD P. SATCHELL
CARBONDALE, ILLINOIS

NELS E. WERNER
CHICAGO, ILLINOIS
JAMES L. YOUNG
SPRINGFIELD, ILLINOIS

November 3, 1977

Dr. James Schlesinger
Secretary
Department of Energy
Washington, D.C. 20585

Dear Mr. Secretary:

I have just scanned a report titled "Potential Radioactive Pollutants Resulting From Expanded Energy Programs" issued August 1977 as EPA-600/7-77-082.

My concern is with present tritium releases from nuclear power plants, especially to Lake Michigan, which is a drinking water source for millions of people, most of whom live in Illinois.

Can you tell me how much tritium has been released to Lake Michigan to date and the resulting radioactivity of the drinking water? Can you tell me the future levels of tritium radioactivity in Lake Michigan assuming (1) no more nuclear power plants discharging to Lake Michigan or to its tributaries and (2) equilibrium being met with the 12.3 years half-life of tritium?

The publication listed above ranks tritium first of all the radionuclides contributing to population exposure doses from nuclear energy systems (see p. ix).

The tritium emission rates used for a Pressurized Water Reactor (PWR) are 1000 Ci to the air and 9000 Ci to the water per 1000 MWe-year (pp. 83 and 97). Can you tell me how existing PWRs on Lake Michigan have compared to this average?

Most energy analysts speak of fusion power as being the real long term energy solution since fossil fuels are finite and solar is not yet developed for centralized power plant purposes.

Fusion will use deuterium and tritium for fuel. It is expected to be "on line" in 1995 according to Rep. Mike McCormack.

Should we not save the tritium now being discharged to Lake Michigan for use as the fuel for fusion? Since tritium is to be made from lithium, itself a finite element, saving tritium now would extend the lithium supply.

Lake Michigan is a cul-de-sac lake. Its "turnover time" is about 100 years. And its southern basin does not mix well with the northern basin. Thus the tritium discharged into the southern basin (south of the ridge near Milwaukee) may well take 200 years to flow out the Straits of Mackinac.

Finally, there are public drinking water intakes near existing PWRs. I saw a study some years ago that placed the dilution at only 5:1 for any nuclides discharged at the Zion PWR and taken in at Waukegan. Could this lack of dilution represent a hazard? What would be the dosages experienced from typical Zion tritium releases (in millirems per year) to people using water from the close-in intakes such as Waukegan?

In summary, Dr. Schlesinger,

a. Tritium will be needed for fusion power after 1995.

b. It is now being discharged into a virtually closed dead-end drinking water source--Lake Michigan.

c. Can we salvage this fuel for posterity?

d. Will we have a radiation hazard to those drinking Lake Michigan water?

I would appreciate any help your staff can give on these concerns.

Sincerely,

Jacob D. Dumelle

Jacob D. Dumelle
Chairman

JDD:llj

FEB 21 1978

Mr. William H. Schmitt
86-21-54 Avenue
Elmhurst, New York 11373

Dear Mr. Schmitt:

Your letter to President Carter, dated November 13, 1977, concerning fish kills from power plants has been passed on to us for reply, since within this Division we have a fairly extensive program related to impacts on fishes and other aquatic resources from the operation of power plant cooling systems. Public uncertainty about these problems has, as you know, been a major cause of delay in construction and operation of facilities on the Hudson and also at Seabrook, New Hampshire. The problems are, as a matter of fact, characteristic of all kinds of power plants using large water flows for cooling purposes and are not restricted to nuclear plants.

We can assure you that the Department of Energy, the Environmental Protection Agency, and the Nuclear Regulatory Commission are doing everything possible to guarantee that the killing of fish and other organisms at these facilities will be reduced to the lowest practicable level, and will hopefully in no case be above a level which the local population is able to sustain without permanent damage. Dr. Webb Van Winkle at our Oak Ridge National Laboratory has been heavily involved in the problems at Indian Point on the Hudson, and has provided a great deal of advice and help to the Environmental Protection Agency in its efforts to determine whether once-through-cooling must be ended in that estuary. Every effort is being made to identify important spawning and nursery areas in advance of siting power facilities so as to avoid unacceptable damage to eggs and larvae. When plants are constructed every effort is made to minimize killing of large fish either at the intake area or in the heated plume on the effluent side of the plant.

MHS-20-3

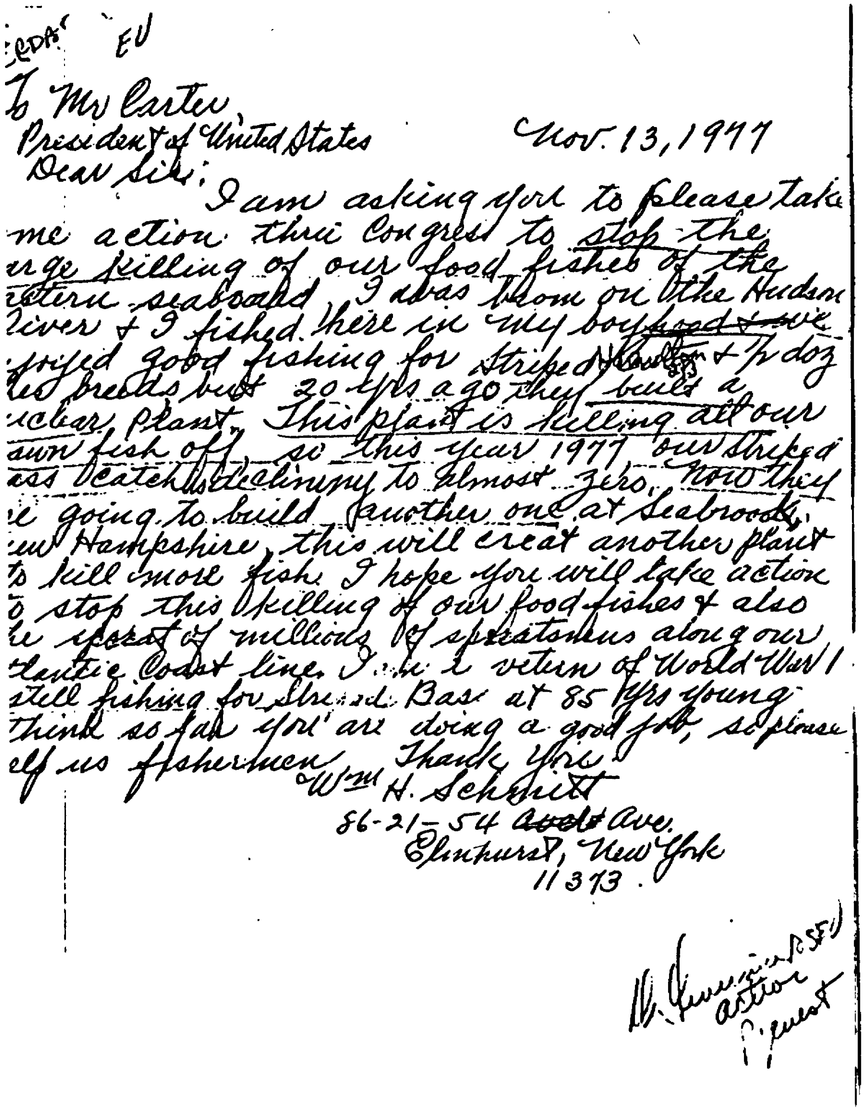
I happen to be a striped bass fisherman myself, although not for an equal number of years, and I can assure you that there are many people like us working for the government and for the utilities who attempt to ensure that we are able to have the electrical power we need without sacrificing valuable natural resources.

Sincerely yours,

D. Heyward Hamilton
Aquatic Ecologist
Environmental Programs
Division of Biomedical and
Environmental Research

bcc: EP Reading File
Hamilton, EP

BE
DH



EDA EU

To Mr Carter
President of United States   Nov. 13, 1977
Dear Sir:

I am asking you to please take me action thru Congress to stop the rge killing of our food fishes of the stern seaboard, I was born on the Hudson River & I fished there in my boyhood & we joyed good fishing for Striped Bass & ½ doz les breeds but 20 yrs ago they built a clear plant, This plant is killing all our awn fish off, so this year 1977 our striped ass catch is declining to almost zero, now they e going to build another one at Seabrook, ew Hampshire, this will creat another plant to kill more fish. I hope you will take action o stop this killing of our food fishes & also e sport of millions of sportsmens along our lantic Coast line. I am a vetern of World War I still fishing for Striped Bass at 85 yrs young think so far you are doing a good job, so please elp us fishermen

Thank You
Wm H. Schmitt

86-21-54 ~~[illegible]~~ Ave.
Elmhurst, New York
11373.

[illegible] (BSF)
action
request

Mr. **Rogers**. And, Mr. Miles, I would hope that you would ask your commanders.

Mr. **Miles**. I will take care of it for the Navy.

Mr. **Rogers**. And furnish that to the committee.

[The Department of Defense supplied the following information for the record:]

In the course of the hearing the Committee expressed concern over the insufficient information provided by the Navy in advance of the hearing. To clarify the Navy's actions on this aspect, the Committee's request for information was stated as follows in a February 22, 1978 letter to the Secretary of the Navy;

"Additionally, the Subcommittee requests that all internal memoranda concerning the work being done by Dr. Thomas Najarian and Professor Theodore Colton and the staff of the Boston Globe relating to radiation and health effects on shipyard workers be provided the Subcommittee by close of business Friday, February 24."

This request was forwarded by the Office of the Secretary of the Navy to the Naval Sea Systems Command Code 08, the Deputy Commander for Nuclear Propulsion, for action. It was received in NAVSEA 08 in the late afternoon of February 23, 1978. In NAVSEA 08 it was received by Mr. William Wegner, Deputy Director. Mr. Wegner showed the letter to Admiral Rickover at the time it was received. On February 23, Mr. Wegner discussed the request with the Navy's Chief of Legislative Affairs who, having conferred with the Committee's staff, confirmed NAVSEA's understanding the request was for documents relating to the work of Dr. Najarian, Professor Colton and the Boston Globe.

Members of Mr. Wegner's staff began assembling the information requested which required a search of files at NAVSEA 08 and checks with the Navy's Bureau of Medicine and Surgery and the Portsmouth Naval Shipyard to ensure a complete package was assembled. The Office of the Secretary of the Navy reviewed their files and provided the few documents held by them to the Committee on February 24, 1978. Due to the short notification time, the demands of preparing for the testimony to be given on February 28, 1978 and the efforts required to respond to numerous press inquiries, the NAVSEA 08 effort carried over into the weekend so that materials were not compiled and made available to the committee until Monday, February 27, 1978. This package contained all documents held by the above cited Navy activities concerning the work of Dr. Najarian, Professor Colton and the Boston Globe as was requested in the Committee's February 22 letter.

As a result of the hearing, it is apparent the Committee desires a broader range of documents than the Navy understood was originally desired. The additional documents are being compiled and it is estimated they will be forwarded to the Committee by 28 March 1978.

Mr. **Rogers**. I am sorry to have to keep you here so long. We appreciate your presence, and we will advise you of the further hearings. Thank you for your presence tonight. the committee is adjourned.

[Whereupon the subcommittee adjourned at 6:43 p.m. to reconvene at the call of the Chair.]

[Additional hearings on Radiation Health Effects of Medical and Diagnostic X-rays were held on July 11, 12, 13, and 14, 1978, Serial No. 95-180, Volume 2.]

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